

Cessna Citation Longitude Model 700

Operators Guide

**THIS DOCUMENT IS FOR USE IN MICROSOFT FLIGHT SIMULATOR
ONLY AND IS NOT INTENDED FOR USE IN ACTUAL FLIGHT
OPERATIONS**

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Operating Limitations

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Weight Limits

Maximum Ramp Weight	39,700 Pounds
Maximum Takeoff Weight	39,500 Pounds
Maximum Landing Weight	33,500 Pounds
Maximum Zero Fuel Weight	26,800 Pounds

Ground Operational Limits

1. Operation of the PITOT/STATIC button in the ON position is prohibited on the ground beyond 2 minutes. Damage to the heated surfaces and equipment may occur if operated beyond this time limit.
2. Wing Anti-Ice is not to be operated while on the ground with engines above idle for greater than 15 seconds while stationary.
3. Sustained engine thrust of 45-55% N1 while stationary on the ground is prohibited with tailwinds greater than 10kts or crosswinds greater than 25kts. Expedite all transitions through this range while on the ground until sufficient ground speed is obtained (10kts or greater).
4. Conditioned air from the APU must be provided if the airplane is operated on the ground for:
 - a. More than 60 minutes at 35C outside air temperature
 - b. More than 30 minutes at 45C outside air temperature

Takeoff and Landing Operational Limits

Operating Limits

Maximum Takeoff and Landing Altitude Limit	14,000 Feet
Maximum Tailwind Component	10 Knots

Operational Considerations

1. Autopilot operation is prohibited during takeoff and landing.
2. Takeoffs and landings on surfaces other than paved runway surfaces are prohibited.
3. Except where indicated in an AFM procedure, speedbrake operation below 500 feet AGL during landing is prohibited.
4. Takeoff with any emergency or abnormal cockpit message is prohibited unless otherwise allowed in an AFM procedure, specifically authorized in an approved MEL, or not applicable for dispatching.
5. Takeoff with BLEED ISOLATE in the XFLOW mode is prohibited. BLEED ISOLATE in the XFLOW mode may be used at 400 feet AGL after takeoff is completed.
6. Changes to the following are prohibited during takeoff until 400 feet AGL:

- a. Engine Anti-Ice buttons
 - b. Wing Anti-Ice buttons
 - c. FLOW bleed air mode
7. Takeoff is prohibited with ice contamination on any of the following surfaces: wing leading edge, winglets, horizontal stabilizer, vertical stabilizer, control surfaces and hinge gaps, engine inlets, engine pylons, windshield, and probes/vanes.

WARNING

Fuel temperature displayed in the cockpit Engine Instruments Sensors display must not be used as a substitute for a visual ice inspection. Temperatures at the fuel tank temperature probes may differ materially from that of the wing leading edge surfaces, where ice may still accumulate.

Enroute Operational Limits

Operating Altitudes

Maximum Operating Altitude	FL450
Maximum Flaps or Gear Extension Altitude	FL180

Operational Considerations

1. PRESS SOURCE buttons and ENG BLEED buttons must be selected to NORM above FL410.
2. ECS must be selected to NORM above FL410

RVSM Operations

The C700 is eligible for Reduced Visual Separation Minimum airspace operations, provided the following equipment is operating normally upon entering the RVSM airspace:

- Pilot and Copilot Primary Altimeters
- Autopilot
- Altitude Alerter
- Transponder

Any changes to any of the aforementioned systems (or changes that affect operation of those systems) must be evaluated for impact on RVSM approval. Eligibility does not constitute operational approval. All crews and operators must comply with required training, practices, and procedures.

Airspeed Limitations

The minimum airspeed in RVSM airspace is 190 knots IAS.

Weight Limitations

The minimum weight in RVSM airspace is 24,400 pounds.

Fuel Limits

Maximum Fuel Imbalance

The maximum lateral fuel imbalance for normal operations is 500 pounds. **A lateral imbalance of 2000 pounds has been demonstrated if an emergency return is required.**

Unusable Fuel

The fuel quantity indications in the cockpit have been calibrated so that no unusable fuel is counted in the quantity indication. While there may still be fuel left in the fuel tanks when the indicator reaches zero, this fuel is not usable by the aircraft in flight.

Engine Limits

Engine Operating Speed, Power, and Temperature Limits

Setting	Max Time	ITT	N2%	N1%
Transient	20 seconds	---	99.90	---
Auto Power	5 Minutes (Multi-Engine)	955	98.62	96.79
Reserve	10 Minutes (Single-Engine)			
Normal Takeoff	5 Minutes (Multi-Engine) 10 Minutes (Single-Engine)	955	98.62	96.79
CLB	Continuous			
Start	N/A	650	---	---

Engine Start Limits

Minimum Start Pressure (EIS Displayed)	32 PSI
Maximum Ground Start Tailwind Component	16 Knots

Three consecutive normal starts followed by 15 minutes of cooling are permitted. Engine dry motoring longer than 20 seconds shall be considered to be one normal start, while engine dry motoring less than 20 seconds does not count against this consideration. Continuous motoring of the engine for up to 5 minutes is permitted, provided that it is followed by a 15 minute cooling period.

Speed Limits

Mmo (above 29,375 feet)

Mach 0.84 Indicated

V _{mo} (8000 feet to 29,375 feet)	325 KIAS
V _{mo} (below 8000 feet)	Linear from 305 KIAS at 8000 feet to 290 KIAS at Sea Level
V _{fe} (Flaps 1)	250 KIAS
V _{fe} (Flaps 2)	230 KIAS
V _{fe} (Flaps Full)	180 KIAS
Maximum Landing Gear Extension Speed	230 KIAS
Maximum Speedbrake Extension Speed	No Limit
Maximum Tire Groundspeed	195 Knots
Max Maneuvering (22,400 lbs, Ground)	156KIAS
Max Maneuvering (22,400 lbs, FL250)	164KIAS
Max Maneuvering (22,400 lbs, FL450)	178KIAS
Max Maneuvering (39,500 lbs, Ground)	222KIAS
Max Maneuvering (39,500 lbs, FL250)	241KIAS
Max Maneuvering (39,500 lbs, FL450)	264KIAS

WARNING

Rapid and/or large control inputs, especially alternating ones and those resulting in large sideslip angles can result in loss of control or structural failures at any speed. Full application of rudder and aileron controls should be confined to below max maneuvering speeds.

Load Factor Limits

Flaps UP	-1.0G to +2.6G
Flaps 1, 2, or FULL	0.0G to +2.0G
Maximum Duration – 0.0G or Less	7 Seconds
Maximum Landing Sink Rate	600 Feet Per Minute

Maneuver Limits

Aerobatic maneuvers, including spins, are prohibited. Intentional stalls are limited to idle thrust only and are prohibited above FL180.

Authorized Operations

This airplane is approved for both daytime and nighttime operations, VFR and IFR operations, and flight into known icing conditions.

Minimum Crew

1 Pilot and 1 copilot are required for all operations. But hey, this is a flight simulator, so, we'll let it slide this time.

Electrical Power Systems

Generator Limits

Engine and APU load limits are set as 100%. Transient loads greater than 100% are permissible, provided amber **GEN LOAD L, R**, and/or **APU** does not appear on the CAS or the load digits do not turn amber.

Battery Limits

Battery temperature must be -20C or greater for APU or engine start.

Auxiliary Power Unit (APU)

Maximum Start Altitude (On Ground)	13,500 Feet
Maximum Start Altitude (2 Gens, 72% N2 min)	15,000 Feet
Maximum Start Altitude (No gens, battery only)	FL310
Maximum Operating Altitude	FL350
Minimum Ambient Air Temp (On Ground)	-40C

APU or APU bleed is prohibited during deice fluid applications of any type. APU bleed may be used after deicing fluid application, but must be subsequently turned off prior to takeoff unless otherwise specified in an AFM procedure.

The APU is approved for unattended operations. Attempting to start the APU is prohibited if an amber **BATTERY VOLTS L** and/or **R** message is displayed on the CAS.

Ice and Rain Protection

Icing Definitions

Icing conditions are defined as visible moisture (fog, rain, drizzle, sleet, snow, or ice) with a temperature of 10C SAT (on ground) or 10C RAT (in flight).

Operational Considerations

1. ENGINE ICE PROTECTION must be selected on when in icing conditions on the ground, except during deice fluid application.
2. To prevent icing of the exterior sensors during critical takeoff operations, the PITOT/STATIC button must be selected on for 15 seconds within 1 minute of takeoff and then returned to NORM when in icing conditions.

3. If icing conditions may be encountered at or below 400 feet AGL, ENGINE, WING, and STAB ICE PROTECTION must be selected ON immediately prior to takeoff.
4. In flight, WING and STAB ICE PROTECTION must be selected ON when below 190 KIAS in icing conditions, ice accumulation can be observed, or the amber **ICING** message is displayed on the EIS or CAS.
5. In flight, the ENGINE ICE PROTECTION buttons must be selected ON when below Mach 0.52 in icing conditions, ice accumulation can be observed, or the amber **ICING** message is displayed on the EIS or CAS.
6. Holding or extended flight in icing conditions with flaps extended is prohibited.
7. WING ICE PROTECTION is prohibited greater than 15C SAT (on ground) or RAT (in air).

Operation in severe icing is strictly prohibited and can result in formation of ice outside of the protected surfaces and/or exceeding the capacity of the ice protection systems.

Thrust Reversers

Operational Considerations

1. Takeoff and Landing Performance without thrust reversers must be used when only a single thrust reverser is available, or when operating on a wet/contaminated runway.
2. Reverse thrust must be reduced to idle by 45 KIAS during landing operations.
3. Reverse thrust is prohibited during touch-and-go operations.
4. Reverse thrust is prohibited to back the airplane at any time.

Angle of Attack System

The angle of attack display may be used as a secondary reference, but does not replace the airspeed display as a primary instrument. Approach speed can be estimated at 0.66 on the AoA gauge at all aircraft weights and configurations.

Garmin G5000 Avionics System

Navigational Limits

1. Category II ILS approaches are not authorized.
2. QFE operations are prohibited.
3. Upon making any flight plan changes, including runways, procedures, and altitude constraints, the flight plan must be reviewed to verify all waypoints and constraints are correct.
4. RNP-APCH [titled RNAV (GPS) or RNAV (GNSS)] to a minimum value of RNP-0.3 is approved with FMS as the active NAV source and at least one GPS sensor functioning.

5. LPV, LP+V, LNAV/VNAV, and LNAV+V approaches are provided by SBAS within applicable SBAS coverage areas. If SBAS is not available, Baro-VNAV will be used for all +V and LNAV/VNAV guidance. LPV is not available without SBAS coverage.
6. A current altimeter setting from the landing airport is required when using baro-VNAV to a DA.

Automatic Flight Control System (AFCS)

Takeoff, Climb, Missed Approach Autopilot Minimums	400 Feet AGL
Approach Autopilot Minimum	160 Feet AGL
Enroute Autopilot Minimum	1000 Feet AGL

Autothrottle may not be armed during taxi operations or before takeoff clearance is received. Autothrottle is prohibited at or below 50 feet AGL during touch-and-go operations.

Approach

1. Approaches must be performed in accordance with the published procedures. The flight crew must verify that the planned approach procedures appear in the navigational database.
2. When conducting approach procedures with FMS guidance, the flight crew must verify that the appropriate and correct approach service level is displayed in magenta on the HSI.
3. The flight crew must verify that the active navigation source is in LOC or BC prior to passing the FAF for ILS, LOC, LDA, and BC approaches.
4. Visual Approach Procedures added to the FMS flight plan are not authorized for terrain and obstacle clearance. The crew must maintain appropriate separation from and visual acquisition of any terrain and obstacles.

Traffic Collision Avoidance System (TCAS II)

1. Pilots operating the aircraft may only deviate from ATC clearance to the extent necessary to execute a TCAS RA (Resolution Advisory).
2. Pilots must visually acquire traffic indicated by a TCAS TA (Traffic Advisory) before executing any evasive actions. Evasive actions based solely on the TA are prohibited.

Radar System

1. Operation of the radar system within 16 feet of persons or flammable material is prohibited.
2. Do not operate the radar system facing radar reflective surfaces that may send energy back towards the aircraft.
3. The area within the front 180 degrees of the nose and within 16 feet is considered to be a hazardous operation area while the radar is active.

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Aircraft Overview

The Cessna Citation C700 Longitude is an advanced dual-turboprop transport aircraft capable of comfortable, high speed, high altitude operations designed to keep passenger comfort high and pilot workload low. Relying on a pair of Honeywell HTF7700L engines, this general and commercial aviation aircraft exhibits exceptional fuel economy and a low operational cost, making it perfect for operators who need a higher range without higher expense.

The airframe has been designed for an excellent piloting experience, with great handling characteristics at all phases of flight. A number of automated systems keep everything in order during normal operations, keeping turnaround times low and keeping the pilot's attention ahead of the plane throughout the flight. With a service ceiling of 45,000 feet, a class-leading cabin altitude of just 5950 feet, and a maximum cruise speed of 0.84Mo, the C700 Longitude is a stellar platform for all transport operations and includes passenger seating availability for 8 in its standard configuration.

The aircraft is certified in the Transport Category in 14 CFR Part 25 (FAA) for daytime, nighttime, VFR, and IFR. Flight into known icing and Category I operations are also approved (Category II operations, an option, are not modeled). Minimum crew is one pilot and one copilot.

Aircraft Systems

Avionics

The Longitude is equipped with the Garmin G5000 suite of avionics and related systems. Components of the Garmin G5000 avionics include:

- Three Large Screen Garmin Display Units (GDUs)
 - Two Primary Flight Displays (PFD)
 - One Multi-Function Flight Display (MFD)
- Four Garmin Touchscreen Controllers (GTCs)
- Two GDU Controllers

The G5000 screens have a flexible display system, allowing the PFDs and MFD to each contain split screens for map, weather, traffic, or systems displays as desired on each pane. Independent pilot and copilot sides are modeled in the simulation. Reversionary modes and the GDU controller functions are not modeled (aside from map range functions and baro).

A Standby Flight Display is provided in the case of avionics failure, and to corroborate data present on the main display units. Rounding out the avionics is an Automated Flight Control System (AFCS) controller, which controls the flight guidance system with integrated autopilot, flight directors and autothrottle.

Electrical System

The Longitude electrical system is based on a nominal 28V DC electrical power system. DC power is provided by each engine via a coupled generator. The electrical system is designed as a split bus system with the ability to tie the two buses should the need arise. Either generator can power the aircraft, via this

architecture. In addition, a hydraulic driven motor/generator, the Power Transfer Control Unit (PTCU), is available as another backup in the case of dual generator failure and will convert hydraulic power from the hydraulic pumps to electrical power for the aircraft.

An APU provides additional electrical power for ground and emergency operations. The Longitude modeled is equipped with the 26.4V Li-Ion batteries, connected to each bus. Electrical system controls are contained on the pilot side lower subpanel underneath the PFD, on the right side of the panel.

Fuel System

The fuel system is comprised of two integral wing fuel tanks, boost pumps, motive-flow ejector pumps, and recirculation pumps. During normal operations, ejector pumps provide fuel to each engine, and the right side boost pump provides fuel to the APU. Fuel transfer between tanks is via the fuel transfer valves, which transfer fuel using the on-side boost pump. A secondary means of fuel transfer, the gravity crossflow valves, allows gravity transfer between tanks. Gravity crossflow is not available on the ground.

Fuel recirculation pumps circulate fuel to maintain even fuel temperatures throughout the entire tank. Recirc pumps are always on during normal operations unless the on-side fuel pump is also running or the fuel level is too low. The fuel recirc pumps may be disabled when required by an AFM procedure.

Fuel controls are contained on the center pedestal, on the right side of the pedestal, fore section (except the FUEL RECIRC button, which is under the spoiler handle on the opposite side of the pedestal).

Engines

The Longitude is powered by dual HTF7700L high-bypass turbofan engines, flat-rated at 7,665 pounds of thrust to ISA +18.9C.

Each engine is controlled via a Full Authority Digital Engine Control (FADEC) unit, which provide automatic start, engine synchronization, and thrust power targets controlled via the cockpit thrust levers. The engines also provide bleed air to the environmental systems, anti-ice systems, and cabin pressurization system. Hydraulically operated thrust reversers provide reverse thrust to reduce brake wear and reduce stopping distances.

Engine start controls are located aft of the throttle quadrant on the center pedestal.

Auxiliary Power Unit

An auxiliary power unit (APU) is installed in the rear of the tailcone and is a self-contained turbine capable of providing bleed air for environmental systems and engine start, as well as electrical power via a coupled driven generator. APU start control is on the aft right side of the center pedestal.

Pneumatics

The Longitude has a comprehensive pneumatic system that supplies bleed air from the engines and APU and delivers it to the environmental systems, engine air starter, anti-ice, and cabin pressurization systems. Bleed air from one engine is sufficient to provide all pneumatic-derived function in the case of single-engine operation.

Pneumatic system related controls are located on the center pedestal aft of the throttle quadrant.

Air Conditioning

Environmental control and air conditioning is driven by an Air Cycle Refrigeration Pack, comprised of heat exchangers and an air cycle machine (ACM). The system is driven by APU or engine bleed air and provides a source of fresh air, temperature & humidity control, and pressurized air for maximum crew and passenger comfort.

In the case of ACM failure or other bleed failures, air may be routed around the ACM and instead directly from the heat exchangers to the air supply. Similarly, air may be routed away from the heat exchangers directly to the ACM.

Temperature control is normally selected on the GTC and will be automatically modulated; however, manual heating and cooling control is available. A recirculation fan keeps the movement of air flowing and is selectable between two speeds or can be automatically controlled.

Controls for the air conditioning system are located just aft of the engine start area on the center pedestal.

Pressurization

Pressurized air is continuously supplied by the air conditioning system, which exits the cabin pressure vessel through the cabin outflow valve. The outflow is controlled by the cabin pressure controller to maintain the desired cabin pressure. A cabin pressure schedule keeps the cabin at as low a cabin altitude as possible for the best possible passenger experience. A cabin altitude of 5,950 feet is maintained at up to altitudes of FL450.

Differential pressure is electronically controlled but an independent relief valve will limit pressure in the event of controller failure.

Controls for pressurization are location in the center of the center pedestal.

Ice and Rain Protection

Heated air from the bleed air system is routed to the engine inlets as well as the wing leading edges. Windshield ice protection is provided by automatically controlled electrical heating elements. Pitot and instrumentation heat is also electrically provided. An electromechanical deice system (EMEDS) is installed, which removes ice from the horizontal stabilizer.

Dual ice detection systems provide direct feedback on icing conditions to the pilot via the EIS and CAS, displaying crew alerts when ice is detected. Wing lights are also provided for visual inspection of the wing leading edges.

Controls are located on the co-pilot lower panel under the PFD, on the left side of the panel.

Hydraulics

Dual hydraulic systems comprised of a hydraulic fluid reservoir, engine driven hydraulic pump, and hydraulic accumulators power each side of the hydraulic system. Speedbrakes, roll spoilers, ground spoilers, brakes, landing gear, thrust reversers, and rudder are powered by the hydraulics system.

Hydraulic accumulators provide stored emergency power for the ground spoilers, nosewheel steering, and parking brake. The Power Transfer Control Unit (PTCU) can use the motor/generator to pump hydraulic fluid through one of the two hydraulic systems in the case of a system failure using electrical power.

Controls for the hydraulic system are located on the right side fore of the center pedestal.

Landing Gear and Brakes

The landing gear are a traditional design with dual trailing-link main gear and a single trailing-link nose gear. The landing gear extension mechanisms are hydraulically actuated, but controlled electrically. Hydraulic powered nose wheel steering provides steering control to the pilots.

The main gear are equipped with carbon disc brakes, which are controlled electronically. The brakes are continuously modulated to prevent wheel skidding and to maintain safe stopping power. Left and right brakes are independently operated based on pedal inputs. Hydraulic accumulators provide power to the emergency/parking brakes in case of hydraulic failure.

Flight Controls

Conventional yoke control to the ailerons and elevator is provided directly to the control surfaces via a standard cable and bellcrank system. Roll control is augmented by hydraulically actuated roll spoilers, which are located on the two outboard spoilers on each wing. Pitch/Roll Disconnect is not modeled, and both pilot and copilot positions have all controls connected at all times.

Electrical aileron, rudder, and horizontal stabilizer trim is available. Secondary stabilizer trim system is not modeled. The rudder is hydraulically actuated by wire using electrical input from the rudder pedals but is not directly connected. A self-contained rudder standby system provides emergency hydraulic rudder power in the event of a hydraulic system A failure.

The roll spoiler panels also double as speedbrakes. Speedbrakes are controllable via a pilot controllable lever and are hydraulically actuated. Ground spoilers are fully automatic and extend during landing or rejected takeoff maneuvers and add the inboard spoiler panel to the deployment of all panels. Hydraulic accumulators provide stored power to the ground spoilers in the event of hydraulic system failure.

Lighting

Interior lighting provides lighting to the passengers and crew during night and low light operations. Interior lighting is controlled via the overhead panel as well as knobs on the outboard side of each lower pilot/copilot panel under the PFD. Instrument backlighting control is available via those knobs as well as two others located aft of the center GTCs.

Exterior lights are low maintenance LED type lights, and include red/green navigation lights, red flashing beacon lights, white flashing anti-collision lights, recognition lights, pulse lights, taxi & wingtip downwash lights, and landing lights.

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Crew Alerting System

The Longitude Crew Alerting System (CAS) alerts pilots to various noteworthy systems changes and abnormalities that require crew attention or overview. The CAS uses a number of avenues to alert the pilots to these events, including the two MASTER CAUTION and MASTER WARNING indicators above the pilot and co-pilot PFDs, aural tones, as well as the CAS digital message alert box on the lower right (pilot) and left (co-pilot) corners of the PFDs.

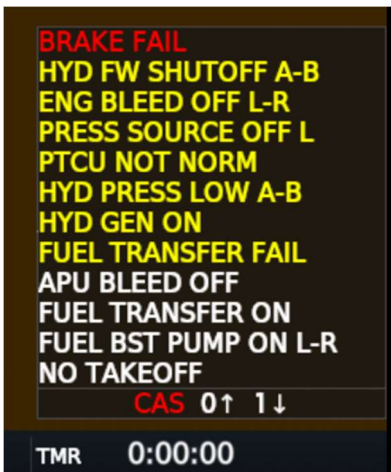


Fig 3-2-1 – PFD Crew Alerting System message display box



Fig 3-2-2 – Master Caution and Master Warning indicator/buttons

Types of Crew Alerts

Red MASTER WARNING alerts require immediate crew attention to avoid critical safety failures, damage, or loss of life. The MASTER WARNING indicator will light, accompanied by an aural tone, and the alert message will be displayed in the CAS area. MASTER WARNING alerts will flash until acknowledged by the crew by pressing the MASTER WARNING button/indicator. After acknowledgement the alert will remain steady red in the CAS area until the condition is cleared.

Amber MASTER CAUTION alerts require immediate attention and subsequent action to maintain adequate levels of safety. When such an alert is triggered, the MASTER CAUTION indicator will light, accompanied by an aural tone, and the alert message will be displayed in the CAS area. MASTER CAUTION alerts will flash amber until acknowledged by the crew by pressing the MASTER CAUTION button/indicator. After acknowledgement the alert will remain steady amber in the CAS area until the condition is cleared.

If the alert clears prior to acknowledgement, the associated indicator light will extinguish, and no acknowledgement will be necessary.

White crew alerts only appear in the CAS area but do not cause any aural tone or cockpit indicator. White alerts do not require explicit crew acknowledgement but should be reviewed nonetheless by the crew to determine if any corrective action is required.

Alert Display Priority

Crew alerts are displayed in the following priority, with the most recent alerts at the top of the associated priority group:

- Red warning alerts
- Amber caution alerts
- White messages

Crew alerts can be scrolled using the on-side PFD GTC. The number of messages that are presently hidden in either direction is displayed at the bottom of the CAS area box.

Crew Alert Inhibits

The Garmin G5000 avionics system includes the ability to inhibit alert messages during critical flight operations. During these operations, messages which are inhibited by the specific inhibit states will not appear on the CAS or cause an indication. Not all messages are inhibited by all inhibit states. Additionally, alerts are debounced, or prevented from transiently triggering if the alert condition is not active for long enough. This prevents the generation of spurious alerts during transitional equipment periods where the alert condition may only be briefly active.

Alerts that were inhibited when an inhibit state becomes active will reappear upon exiting the inhibit state, if the alert condition is still active. The Longitude includes the following inhibit states:

Takeoff Operation Phase Inhibit (TOPI)

The Takeoff Operation Phase Inhibit is active if any of these conditions is true, to prevent distracting messages during the critical takeoff phase:

- The airplane has transitioned from the ground to the air
- The indicated airspeed moves from below to above 85 KTS
- The indicated airspeed is greater than 30 KTS and there is a brake failure

The inhibit state is cancelled if any of these conditions is true:

- The aircraft weight-on-wheels sensors indicate the aircraft is in the air for greater than 30 seconds
- The aircraft pressure altitude is greater than 400 feet AGL
- The indicated airspeed is less than 30 KTS
- The indicated airspeed is less than 50 KTS and there is not a brake failure

- The inhibit state has been active for more than 90 seconds
- The throttle is no longer in the T/O position

Landing Operation Phase Inhibit (LOPI)

The Landing Operation Phase Inhibit is active if any of these conditions is true, to prevent distracting messages during the critical landing phase:

- The aircraft has transitioned from the air to the ground
- Radio altitude moves from greater than 400 feet AGL to less than 400 feet AGL

The inhibit state is cancelled if any of these conditions is true:

- The aircraft has been on the ground for greater than 30 seconds
- Radio altitude is greater than 500 feet AGL
- Indicated airspeed is less than 50 KTS
- The inhibit state has been active for greater than 90 seconds

Other Inhibit States

The Longitude also implements the following inhibit states and conditions:

- In Air – The aircraft is in flight with no weight-on-wheels
- On Ground – The aircraft is on the ground with weight-on-wheels
- Engine Shutdown Inhibit (ESDI) – At least one engine is presently shutdown
- Engine Fail Inhibit (EFI) – An ENGINE FAIL MESSAGE is posted
- Emergency Bus Mode Inhibit (EMER) – Either EMER bus is not receiving power
- Main Bus Inhibit – Either main bus is not receiving power
- Mission Bus Inhibit – Either mission bus is not receiving power

Crew Alert Messages

Red Warning Messages

Alert	Description	Inhibits
BATTERY O'TEMP L/R	The battery temperature has increased to an unsafe level, beyond 71C.	TOPI LOPI
BRAKE FAIL	The brakes have been rendered inoperative and the aircraft is below 400 feet AGL. Only emergency/parking brakes will be available.	TOPI
CABIN ALTITUDE	The cabin altitude is at an unsafe level, above 9,800 feet (or 14,800 feet when in high altitude mode).	TOPI LOPI
CABIN DELTA P	The cabin differential pressure has exceeded the design limitations (greater than 10.2 PSI).	TOPI LOPI
ENG EXCEEDANCE L/R	The engine parameters (N1, N2, ITT) have exceeded limitations. An exceedance must be noted in the maintenance log.	TOPI LOPI
ENGINE FAIL L/R	The FADEC has detected an engine failure.	None
GENS OFF	There are generators available for DC power, but all available generators have been selected off.	TOPI LOPI ESDI
HYD O'TEMP A/B	The hydraulic system fluid temperature has exceeded limits (above 135C).	TOPI LOPI
LANDING GEAR	The landing gear are not correctly configured: landing gear not down and locked with flaps full OR landing gear not down and locked at less than 500 feet AGL and near idle throttle	None
NO TAKEOFF	Conditions for takeoff listed in the pre-flight synoptic page have not been appropriately met and takeoff is prohibited.	In Air
P/S BUTTON ON	The PITOT/STATIC anti-ice button is selected to ON, but the aircraft is on the ground, which can result in sensor and/or aircraft damage.	TOPI LOPI

Yellow Caution Messages

Alert	Description	Inhibits
A/I ENG OFF L/R	Engine anti-ice is selected on, but the system has detected that no engine anti-ice is being provided.	TOPI LOPI
A/I WING OFF L/R	Wing anti-ice is selected on, but the system has detected that no wing anti-ice is being provided.	TOPI LOPI
APU BLEED OFF	APU bleed air was selected OFF while on the ground.	TOPI LOPI
APU ON	The APU was selected on and running above FL350	TOPI LOPI
BATT DISCHARGE L/R	The battery has been in a discharging state for 5 or more minutes.	TOPI LOPI
BATTERY AMPS L/R	The battery charging or discharging amperage is greater than 300A.	TOPI LOPI
BATTERY LOW TAKEOFF	The battery charging amps are greater than 20A and the throttles have been advanced to a takeoff throttle position.	TOPI LOPI In Air
BATTERY O'TEMP L/R	The battery has reached a critical temperature over 63C.	TOPI LOPI
BATTERY OFF L/R	The battery has been disconnected from its bus.	TOPI LOPI
BATTERY VOLTS L/R	The battery voltage is critically low, indicating low charge life remaining.	TOPI LOPI
BLEED ISOLATE NORM	The bleed isolate has been selected to NORM with an engine shutdown in-air for greater than 2 minutes OR while attempting an in-air engine start.	TOPI LOPI
BLEED ISOLATE XFLOW	The bleed isolate has been selected to XFLOW for more than 5 minutes with both engines providing bleed air OR while on the ground with the throttles advanced to takeoff.	TOPI LOPI

BRAKE FAIL	The brakes have been rendered inoperative. Only emergency/parking brakes will be available.	TOPI LOPI
BRAKE TEMP L/R	The brakes have reached a critical temperature, over 450C.	TOPI LOPI
BUS TIE CLOSED	The electrical bus tie has been closed for more than 5 minutes, but both generators are connected.	TOPI LOPI
CABIN ALTITUDE	The cabin altitude is greater than 8,500 feet OR the system is in high alt mode and the cabin altitude is greater than 9,800 feet for more than 10 minutes.	TOPI LOPI
ELEC EMER	The electrical bus has been set to EMER, resulting the disconnection of the EMER and MISSION buses.	TOPI LOPI
EMER BUS OFF	The EMER bus has been disconnected.	TOPI LOPI
ENG BLEED OFF L/R	Engine bleed air was selected OFF while on the ground.	TOPI LOPI
FUEL IMBALANCE	The difference in fuel between the left and right tanks has exceeded 500 pounds	TOPI LOPI
FUEL INLET COLD L/R	The temperature of the fuel at the engine fuel inlet is less than 3C.	TOPI LOPI
FUEL LEVEL LOW L/R	The amount of fuel remaining in the tank is less than 500 pounds.	TOPI LOPI
FUEL TANK COLD L/R	The temperature in the fuel tank is below -35C.	TOPI LOPI
FUEL TEMP MISCOMPARE	The difference in the fuel temperature between the left and right tanks exceeds 5C.	TOPI LOPI
FUEL TRANSFER FAIL	The fuel transfer valve has been set to transfer fuel, but both boost pumps are on, netting a zero fuel transfer between tanks.	TOPI LOPI
FUEL TRANSFER ON	The fuel transfer valve has been set to transfer fuel to a tank with 60 pounds or more fuel greater quantity than	TOPI LOPI

	the tank being transferred from OR fuel transfer has been on for more than 10 minutes.	
GEAR DISAGREE L/R/N	The gear handle position and physical position of the landing gear do not agree (i.e. the gear handle position is down but the gear are locked up, or the gear handle position is up but the gear are locked down).	TOPI
GEN LOAD L/R/APU/HYD	The generator load has exceeded 75% available load capacity.	TOPI LOPI
GEN OFF L/R/APU	The generator is operational and available, but the generator has been selected to OFF.	TOPI LOPI
GND SPOILER FAIL	Two or more of the four ground spoiler hydraulic accumulators has insufficient pressure to operate the actuators. Ground spoiler function may be unavailable.	TOPI LOPI
GRD SPOILER ACCUM	One of the four ground spoiler hydraulic accumulators has insufficient pressure to operate the actuators. Ground spoiler function may be degraded.	TOPI ESDI
HEAT EXCHG ONLY	The ECS selection knob is NOT set to HEAT EXCHG ONLY when the cabin altitude has exceeded limits.	TOPI LOPI
HYD GEN ON	The PTCU hydraulic generator is on and active, but another generator source is also available for use.	TOPI LOPI
HYD PRESS LOW A/B	The hydraulic system pressure is low.	TOPI LOPI
HYD SHUTOFF A/B	A hydraulic pump has been selected to SHUTOFF but the generator is presently available for hydraulic pressure.	TOPI LOPI
MAIN BUS OFF L/R	The electrical MAIN bus has been disconnected.	TOPI LOPI
MISSION BUS OFF L/R	The electrical MISSION bus has been disconnected.	TOPI LOPI
PARK BRAKE LOW PRESS	The parking brakes are receiving low hydraulic pressure. Parking brake function may be degraded.	TOPI LOPI

PARK BRAKE ON	The parking brake is still engaged but the throttles have been advanced to the takeoff position.	TOPI LOPI
PRESS MODE MANUAL	The cabin pressurization system has been selected into manual mode via the cockpit mode button.	TOPI LOPI
PRESS SOURCE OFF L/R	The aircraft is in air, but one of the pressure sources has been selected to OFF.	TOPI LOPI
PTCU NOT NORM	The PTCU is not selected to NORM for engine start, running, or dry motoring.	LOPI In Air
RUDDER FAIL A/B	The rudder channel has failed due to insufficient hydraulic pressure and an unavailable or failed rudder standby system. Rudder control will not be available.	TOPI LOPI ESDI
RUDDER STANDBY OFF	The rudder standby system has been selected to the OFF position.	TOPI LOPI
SPEEDBRAKE AUTO STOW	The speed or throttle settings have exceeded the maximum available for speedbrake deployment. Speedbrakes have been automatically stowed.	TOPI LOPI
SPEEDBRAKES	The speedbrakes are in use at an unsafe altitude, below 500 feet AGL.	TOPI
YAW DAMPER FAIL A/B	The yaw damper on the rudder channel has failed due to hydraulic pressure and an unavailable or failed rudder standby system. The yaw damper will not be available.	TOPI LOPI ESDI

White Messages

Alert	Description	Inhibits
A/I ENG ON L/R	Engine anti-ice has been selected ON. This message will not appear when all anti-ice systems are simultaneously selected ON.	TOPI LOPI
A/I WING ON	Wing anti-ice has been selected ON. This message will not appear when all anti-ice systems are simultaneously selected ON.	TOPI LOPI
A/I WING XFLOW OPEN	The bleed isolate mode has been selected to XFLOW and the wing A/I crossflow valve is open and functioning.	TOPI LOPI
ACM ONLY	The ECS has been selected to the ACM ONLY setting.	TOPI LOPI
APU BLEED OFF	The APU bleed air has been selected to OFF.	TOPI LOPI
APU ON	The APU has been selected to ON and is running above FL200.	TOPI LOPI
BLEED ISOLATE XFLOW	The bleed isolate has been selected to XFLOW.	TOPI LOPI
BUS TIE CLOSED	The electrical bus tie has been selected or automatically closed.	TOPI LOPI
CABIN ALTITUDE	The pressurization system is in high alt mode and the cabin altitude is greater than 8,000 feet.	TOPI LOPI
ENG BLEED OFF L/R	The engine bleed air has been selected to OFF.	TOPI LOPI
ENG DRY MTR PROC L/R	An engine dry motoring procedure is required.	TOPI LOPI In Air
ENGINE SHUTDOWN L/R	And engine has been shut down via the RUN/STOP button.	None

FUEL BOOST PUMP ON L/R	The fuel boost pump has been selected ON manually or automatically.	TOPI LOPI
FUEL GRV XFLOW ON	The fuel gravity crossflow has been selected ON.	TOPI LOPI
FUEL TRANSFER ON	The fuel transfer selector has been selected to the left or right transfer position.	TOPI LOPI
HEAT EXCHG ONLY	The ECS has been selected to the HEAT EXCHG ONLY setting.	TOPI LOPI
HYD AUX PUMP ON A/B	The PTCU has been set to the AUX position to provide auxiliary hydraulic pressure to the system.	TOPI LOPI
HYD FW SHUTOFF A/B	The hydraulic system has been selected to SHUTOFF.	TOPI LOPI
HYD GEN ON	The PTCU hydraulic electrical generator has been selected on.	TOPI LOPI
ICE PROTECT ALL ON	All anti-ice systems are active (engine left, engine right, wing, and stabilizer).	TOPI LOPI
PARK BRAKE ON	The parking brake is currently engaged.	TOPI LOPI
PITOT STATIC ON	The PITOT/STATIC anti-ice has been selected ON and the aircraft is in air.	TOPI LOPI
PRESS SOURCE OFF L/R	The bleed air PRESS SOURCE has been selected to OFF.	TOPI LOPI
PTCU OFF	The PTCU has been selected into the OFF position.	TOPI LOPI
STAB DE-ICE ON	Stabilizer de-ice has been selected ON. This message will not appear when all anti-ice systems are simultaneously selected ON.	TOPI LOPI

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IV - Avionics

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Avionics System Overview

Garmin G5000 Description

The Cessna Citation C700 Longitude comes with a full Garmin G5000 large-display glass cockpit installation, which is modeled to a very high degree of visual and behavioral authenticity. The Garmin G5000 avionics suite is an integrated glass cockpit solution containing everything needed for flight including instrumentation, flight plan management, automatic flight control systems, communications, and system configuration. The G5000 system is controlled via the Garmin Touch Controller touchscreen interfaces, located to the left and right of the pilots.

While a full overview of the operation and function of the G5000 is beyond the scope of this operator's guide, some general usage information will be provided below.

Displays

The Garmin G5000 contains the following displays:

- Three Large Screen Garmin Display Units (GDUs)
 - Two Primary Flight Displays (PFD)
 - One Multi-Function Flight Display (MFD)
- Four Garmin Touchscreen Controllers (GTCs)

Fully independent left and right side displays are also modeled, which can be independently controlled.

Modeled System Components

The following system components are modeled in the G5000:

- Dual Air Data Computers (ADCs)
- Dual Attitude and Heading Reference Systems (AHRS)
- Dual GPS navigation Receivers (with full real-time satellite position modeling and SBAS simulation)
- Flight Management System (FMS)
- ADS-B Transponder System
- Full specification-accurate TCAS-II traffic collision avoidance system with Traffic *and* Resolution Alerts
- COM and NAV radios including independent radios for DME hold

Flight Displays

The G5000 system splits the 3 displays into two main groups: the PFDs for the pilot and co-pilot, and the MFD which contains maps and instrumentation, shared between the pilot and co-pilot, in the middle of the cockpit display panel area.

Primary Flight Display Overview

The PFDs contain the primary flight instruments, including the airspeed tape, the altimeter tape, the attitude indicator, the artificial horizon, the horizontal situation indicator, information about the current flight plan leg, automatic flight guidance modes, and tuned COM radio information. Inset maps and traffic displays can also be turned on if desired.



Fig 4-3-1 – The Primary Flight Display



Fig 4-4-1 – The Primary Flight Display, in Split Mode

The PFD can also be split into two separate panes, which can then be controlled with the inboard MFD GTCs. These panes can contain a moving map, weather radar returns, systems synoptics pages, or traffic displays.

The PFD is primarily controlled via the outboard PFD GTCs.

Airspeed Indicator

The airspeed indicator shows the pilot the current aircraft indicated airspeed, as well as speed limit ranges, speed targets, any speed bugs, and speed trends.

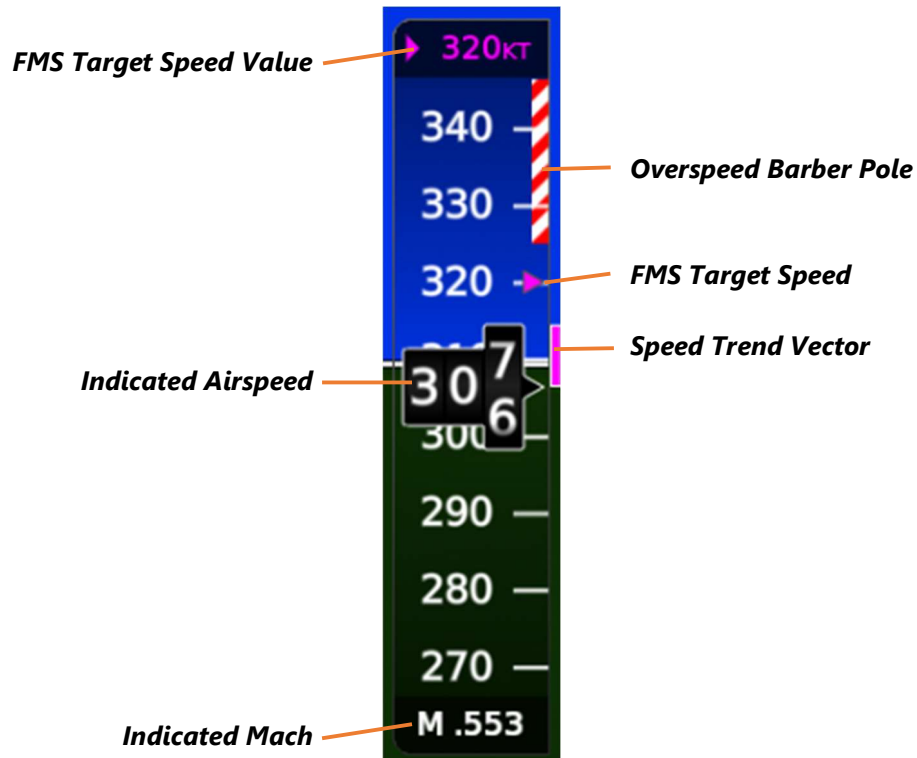


Fig 4-4-1 Airspeed Indications

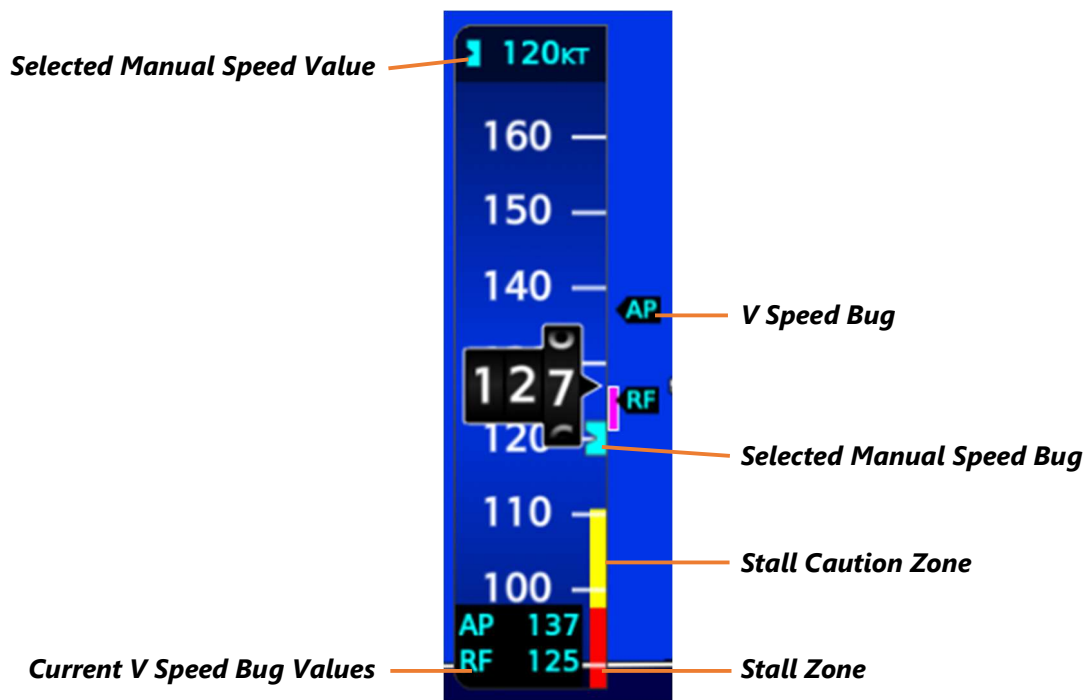


Fig 4-4-2 – Airspeed Indications

Altimeter and Vertical Speed Indicator

The altimeter tape shows the current altitude, the preselected altitude capture altitude, the altitude trend vector, the preselected altitude bug, the minimums bug, and the current altimeter baro setting. The vertical speed indicator shows the current vertical speed, the selected vertical speed, and the selected vertical speed bug.

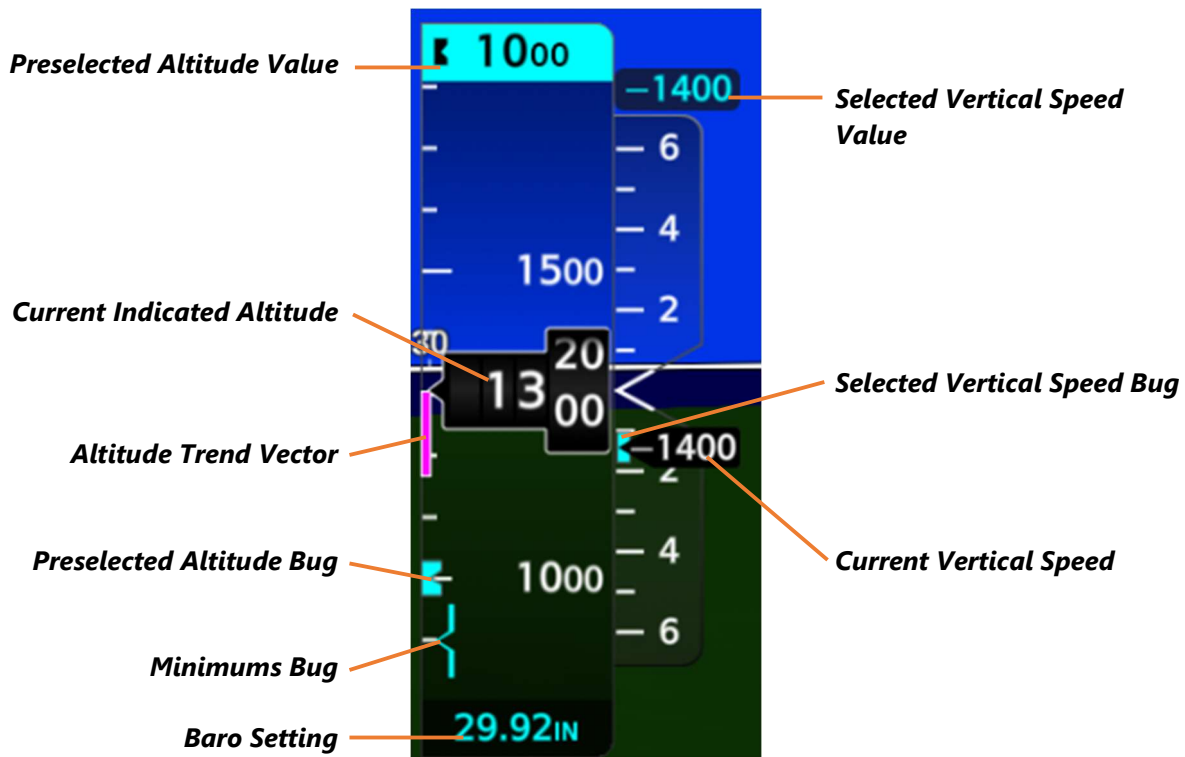


Fig 4-5-1 – Altimeter and Vertical Speed Indicator

Altimeter STD BARO Mode

The altimeter can be toggled in and out of STD BARO by pushing the BARO button on the display controller above the PFD. Once in STD BARO, the altimeter may be preset using the BARO knob. The altimeter will automatically be set to the preset baro setting when exiting STD BARO.



Fig 4-5-2 – Altimeter STD BARO indications

Angle of Attack Indicator

The angle of attack indicator displays the currently measured angle-of-attack as a range from 0 (0 degrees angle of attack) to 1.0 (stall angle of attack). The amber range is from 0.8 to 1.0, and corresponds to the amber stall warning area on the speed tape. The stick shaker will engage to alert the pilot to an impending stall when entering stall warning ranges.

Approach speeds can be referenced in the absence of other performance data or V Speeds by targeting an angle of attack value of 0.66. The AOA indicator will be displayed automatically when landing gear are down and any flaps value is set, or it may be manually activated in the PFD Settings page on the PFD GTC.

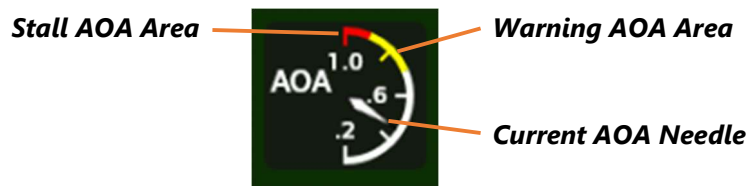


Fig 4-6-1 – Angle of Attack Indicator

Horizontal Situation Indicator (HSI)

The horizontal situation indicator displays the compass rose, the currently selected heading reference, the desired track to the current waypoint, the amount of crosstrack error from the desired path (XTK), the currently selected nav source, and the flight phase/CDI scaling/approach service level.



Fig 4-6-2 – Horizontal Situation Indicator

When the selected nav source is a radio nav source, the course needles will change to green. The course needles are magenta when FMS is the selected nav source. The flight phase field appears while the selected nav source is FMS and displays the current CDI scaling mode or the obtained RNAV approach service level when on an RNAV approach.

A turn trend indicator shows a magenta arrow indicating the trend of the heading predicted, and is located just above the compass rose underneath the current heading.

AFCS Status Box

The current status of the automated flight control system is displayed at the top of the PFD, and includes indications for the current autothrottle mode, the current autothrottle target speed, the current lateral armed & active modes, the current vertical armed & active modes, and the status of the autopilot and autothrottle engagement.

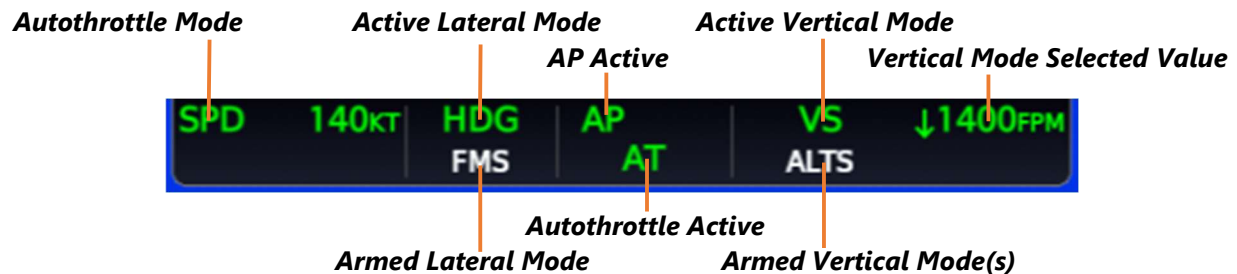


Fig 4-7-1 AFCS Status Box

The AFCS status box has the following fields:

- Autothrottle mode: Displays the current autothrottle mode and autothrottle speed target, if applicable. Not all autothrottle modes will display a speed target
- Active lateral mode: The currently directed lateral guidance mode. This will flash amber reverse video if the active lateral mode is lost.
- Armed lateral mode: The currently armed lateral guidance mode. When becoming active, this will disappear from this field, and instead switch to the active field, accompanied by a flashing mode value to indicate that the active mode has changed.
- AP active: Displays whether or not the AP is active. This displays a green AP when the autopilot is active. This field will flash amber reverse video when the autopilot is disconnected.
- Active vertical mode: The currently directed vertical guidance mode. This will flash amber reverse video if the active vertical mode is lost.
- Vertical mode selected value: The value to target for the currently active vertical guidance. This may be a vertical speed (displayed with direction arrow), an FLC speed, or an altitude.
- Armed vertical mode(s): The currently armed vertical guidance mode(s). More than one mode may appear here if multiple modes are armed, e.g. ALTS VPATH
- Autothrottle active: Displays whether the autothrottle is active. This displays a green AT when the autothrottle is active. This will flash amber reverse video if the autothrottle is disconnected.

NOTE:

The AFCS status box does not display any yaw damper indication. The yaw damper of the Longitude is fully automatically controlled and does not require any pilot engagement or disengagement.

Multi-Function Display Overview

The MFD contains the Engine, Instruments, and Systems display (EIS) on the left side of the MFD screen. This EIS display is always visible and cannot be hidden. The MFD is capable of dual or single pane operation (full screen) and can hold moving maps, weather radar returns, systems synoptics pages, or traffic displays. Not all display panes can be used in full screen mode, such as the systems synoptics, which may only be displayed in a half screen pane.



Fig 4-6-1 – Multi-Function Display in Full Screen Mode



Fig 4-6-2 – Multi-Function Display in Split Pane Mode

PFD Garmin Touch Controller

The PFD is primarily controlled via the outboard PFC GTC, located to the left (pilot) or right (co-pilot) of the main PFD screen. The PFD GTC allows for management of the COM radios via the top communications bar, or by pressing the Audio & Radios button.

The PFD GTC also allows for configuring the active nav source, managing OBS mode, scrolling the CAS window, managing any bearing pointers to be displayed within the HSI, manually adjusting speed bugs on the airspeed tape, configuring any timers, and setting minimums.

A number of PFD map settings are also available, including inset maps (displayed only in full screen mode) or the HSI moving map. A traffic map shortcut on the top right of the screen displays the traffic inset map. Additional PFD settings for wind data display, AoA indication, PFD baro units, meters altitude overlay, synthetic vision, and others, are available using the PFD Settings button.



Fig 4-7-1 – The PFD Garmin Touch Controller

MFD Garmin Touch Controller

The majority of the navigation and flight management functions are accessed via the MFD GTCs, which are located underneath the MFD, to the right or left of the pilot. All flight management functions are only available via this GTC, and any pane management for the PFD split pane is also only available via this GTC. Split panes on the PFD are not controlled via the PFD GTC.

The MFD GTC also allows for quick management of the COM radios via the top communication bar. Other radios may be accessed using the Audio & Radios button on the top left of the GTC interface. A

transponder shortcut area is on the top right corner of the GTC, and allows access to the transponder modes and code tuning.



Fig 4-8-1 – MFD Garmin Touch Controller

The Map, Traffic, and Weather buttons will switch the selected pane to the moving map, traffic display, or radar display respectively. If the pane is already selected to that page, pressing the button will open the settings page for that particular type of pane on the GTC interface.

The Direct-To, Flight Plan, and PROC buttons will take you to those flight management functions on the GTC interface, while the Aircraft Systems button will take you to the Longitude systems management page. The Utilities button will open the utilities GTC page, which allows access to timers, minimums, avionics settings setup, and GPS status.

On the bottom row of the MFD Home screen, you can access PERF (allows takeoff, landing, and enroute performance data to be entered and calculated for V Speeds), Waypoint Info (Airport, VOR, NDB, intersection information, as well as user waypoint info/creation), or Nearest (nearest airports, VORs, NDB, intersections, and user waypoints). Finally, the bottom physical knobs of the GTC are very multifunctional, with the present functions available in the current page context displayed on the bottom of the GTC above the respective knob. Note that the knobs can be rotated, used in a joystick fashion, and/or pushed like a button depending on the current GTC context.

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V - Electrical System

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Electrical System Overview

The Longitude electrical system is of a dual-bus DC powered design. Each bus half consists of a battery and engine driven generator. Modeled on this Longitude are the optional 26.4V Li-Ion batteries. Additionally, an APU driven generator can provide power to the system, as well as the hydromechanically powered PTCU motor-generator, which gives the Longitude exceptional power redundancy. The buses are isolated during normal operations but may be tied together if required.

An independent standby instrument battery provides power to the standby flight instruments in the cockpit.

Simulation Notes

The Longitude includes a custom electrical system containing all of the numerous automation features found on the real aircraft, such as the automated bus tie system and automated generator bus connection. Cockpit equipment is powered by the correct buses, and a simulation of correct charging amperage has been built using real charge curves and battery resistance values. The PTCU, a unique item on the Longitude that allows generation of power from hydromechanical energy, has also been fully modeled and will provide power to the systems if engaged.

Electrical Buses

Each electrical system bus half is split into a few sub-buses for isolation during abnormal operations.

- Hot Battery Bus: The battery is always connected to this bus, and powers a few small items.
- Service Bus: This bus powers a number of exterior service items (not modeled) as well as redundant fuel system power.
- Emergency Bus: This bus powers all equipment strictly necessary to land the aircraft in an emergency.
- Mission Bus: The bus powers all items required to fly the aircraft normally, but without system redundancy. The PTCU hydraulic motor-generator can provide enough power to support the Mission and Emergency buses.
- Main Bus: This bus powers optional and system redundancies. An engine or APU generator is required to sufficiently supply main bus power during flight operations.
- Interior Bus: This bus powers cabin items.
- Standby Bus: This bus powers the standby flight instruments.

Main Batteries

The dual main batteries are a Li-Ion type, with a nominal 26.4V at full charge and 44 amp-hours. The batteries are sufficient to provide power to the items on the Emergency Bus for over 40 minutes, if the electrical bus is set to EMER within 5 minutes of power loss.

Standby Battery

The standby battery is a 24V, 10.4 amp-hour lead-acid battery with integral diagnostic and test systems. It can be tested using the STBY PWR switch. The standby battery is connected to the Left Mission Bus for charging only, and will supply at least 180 minutes of power to the standby instruments in case of an electrical failure.

Engine Generators

An engine driven generator is mounted to each engine and provides power to its half of the dual-bus electrical system. The generators are 28V, rated for 400A of power supply on the ground and 500A of power supply during flight operations.

APU Generator

One APU driven generator is mounted to the APU and is also 28V, providing 500A of power on the ground and 400A of power during flight operations. The APU is connected to the left electrical bus system, but can provide power to both sides when the buses are tied.

Power Transfer and Conversion Unit (PTCU)

The PTCU hydromechanical motor-generator can operate in generator mode to convert hydromechanical power provided by the engine driven hydraulic pumps to electrical power available for system consumption. The PTCU provides 28V power with a maximum supply load of 200A. The PTCU generator can supply enough to operate the emergency and mission buses in their entirety if required.

External Power

External power may be supplied to the aircraft via an external power connection. External power is not required for charging the batteries or starting the APU. Battery power is sufficient for APU start, and the APU generator is sufficient for charging the batteries.

Electrical System Controls



Fig 5-3-1 – Electrical System Controls

L/R MAIN Buttons

The L and R MAIN buttons control power from the on-side electrical bus to the Main bus. This momentary press button has the following states:

- ON (Cyan): The MAIN bus is connected to the on-side bus via a connection to the MISSION bus.
- OFF (White): The MAIN bus is disconnected from the on-side bus. Setting MAIN to OFF triggers the **MAIN BUS OFF L/R** message to alert the pilots to this condition if it was not intended.

L/R ELEC Buttons

The L and R ELEC buttons control the connection between the MISSION and EMER buses. Because the MAIN and INT buses connect via the MISSION bus, this also can affect power to those buses. This momentary press button has the following states:

- ON (Cyan): The MISSION and EMER buses are connected.
- EMER (Amber): The MISSION and EMER buses are isolated from each other. Power to the MISSION bus and the MAIN & INT buses (via the MISSION bus) will be available via the on-side engine generator only. Setting ELEC to EMER triggers the **ELEC EMER L/R** message to alert the pilots to this condition if it was not intended.

INTERIOR Button

The INTERIOR button controls the connection of **both** side interior buses to their respective MISSION buses. This momentary press button has the following states:

- NORM (Cyan): The INTERIOR bus system logic handles the connection of cabin electrical items to the bus.
- OFF (White): The INTERIOR buses are disconnected from the MISSION buses.

STBY PWR Switch

The STBY PWR switch controls solely the connection of the standby battery bus to the standby flight instruments. The standby battery does not provide power to any other systems. The STBY PWR switch has the following positions:

- ON: The standby flight instruments are powered. If the switch is in this position and the standby battery is not actively being charged, an amber LED indicator to the left of the switch will light to alert the pilot to this condition.
- OFF: The standby flight instruments are not powered.
- TEST: Tests the charge of the standby battery. The switch must be held in this position during the test, and a green LED indicator to the left of the switch will light to indicate if the standby battery has sufficient power. Receiving a green light indicator for greater than 3 seconds while the TEST position is held is sufficient to determine that the battery has enough charge remaining.

L/R/APU GEN Switches

The L and R GEN switches control the connection of the on-side engine driven generators to the MISSION buses. The switches have the following positions:

- ON: The engine or APU driven generator is connected to the MISSION bus. It is safe to leave the switch in this position, as the electrical system logic will prevent the connection of the engine or APU driven generator to the bus unless the generator is ready and stabilized. After the generator is ready and stabilized, the system will automatically connect the generator to the bus.
- OFF: The generator is disconnected from the MISSION bus. Setting GEN of OFF will trigger the **GEN OFF L/R** message to alert the pilots to this condition if it was not intended.
- RESET: The generator logic system will be reset. This position is non-latching and will return to the OFF position when released.

BUS TIE Button

The Longitude bus tie system is highly automated to relieve pilots of nuisance button presses during power up operations. When on the ground, pressing the BUS TIE button performs no action, as it is fully automated. Pressing the button in the air toggles between the two available states.

On the ground the bus tie is normally open, but will be closed (tied) by the automation in any of the following conditions:

- A primary power source (engine generator, APU generator, or external power) is only connected to one bus half. The bus will be tied so the primary power source can provide power to both bus sides.
- Only one battery is online. The bus will be tied so the single battery can provide power to both bus sides. This will only occur once during initial power up, and the bus tie is prevented from closing if one battery is shutdown at a time. Once power is fully removed, this logic is reset.
- During an APU start request. The bus will be tied to ensure the APU receives sufficient power during this high load operation.

The BUS TIE momentary button has the following states:

- OPEN (Cyan): The two electrical side buses are not tied.
- CLOSED (Amber): The two electrical side buses are tied. While in this state the BUS TIE CLOSED message will appear to alert the pilots. If both electrical side buses have a connected primary source of power and BUS TIE is CLOSED for more than 5 minutes, this message will turn to a yellow caution message to alert the pilots to this condition if it was not intended.

L/R BATT Buttons

The L and R BATT buttons control the connection of the on-side hot battery bus to the EMER bus. This momentary button has the following states:

- ON (Cyan): The battery is connected via the EMER bus.
- OFF (Amber): The battery is disconnected. Setting BATT to OFF will trigger the **BATTERY OFF L/R** message to alert the pilots to this condition if it was not intended.

PTCU HYD GEN Knob Position

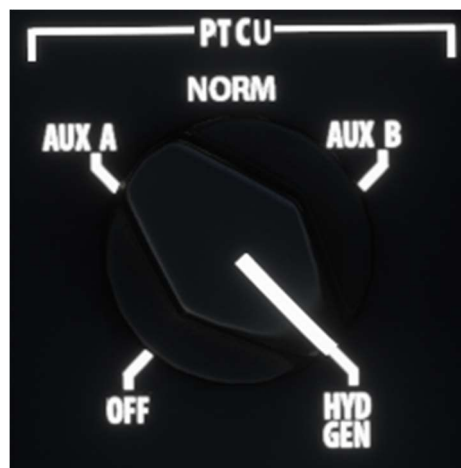


Fig 5-6-1 – PTCU knob selected to the HYD GEN position

The Power Transfer and Conversion Unit may also serve as a generator. To engage the PTCU in a generator mode, the knob can be moved to HYD GEN. This will power the motor-generator from

hydraulic system A. Moving away from the HYD GEN position and back after 1 second will switch the source of hydraulic power to hydraulic system B.

Setting PTCU to HYD GEN will trigger the HYD GEN ON message. If another primary power source is available, this message will turn into a yellow caution message.

Electrical System Indications

EIS Indications

The EIS will display the sensed battery volts and amps at the bottom of the EIS display. Negative amp numbers indicate the battery is discharging, while positive amp values indicate the battery is charging. The digits will turn amber reverse video if the values are not within the normal operating range.



Fig 5-6-2 – Electrical EIS Display

Synoptics Indications

The electrical synoptics pane will display the current state of the components of the electrical system, including bus connection states, power flows, generator states, and battery states. Digits on the pane will turn amber reverse video if they are not within the normal operating range. Flow lines will be green when receiving power and connected to power sources.

The electrical synoptics pane is accessed via the Systems page on one of the MFD GTCs.

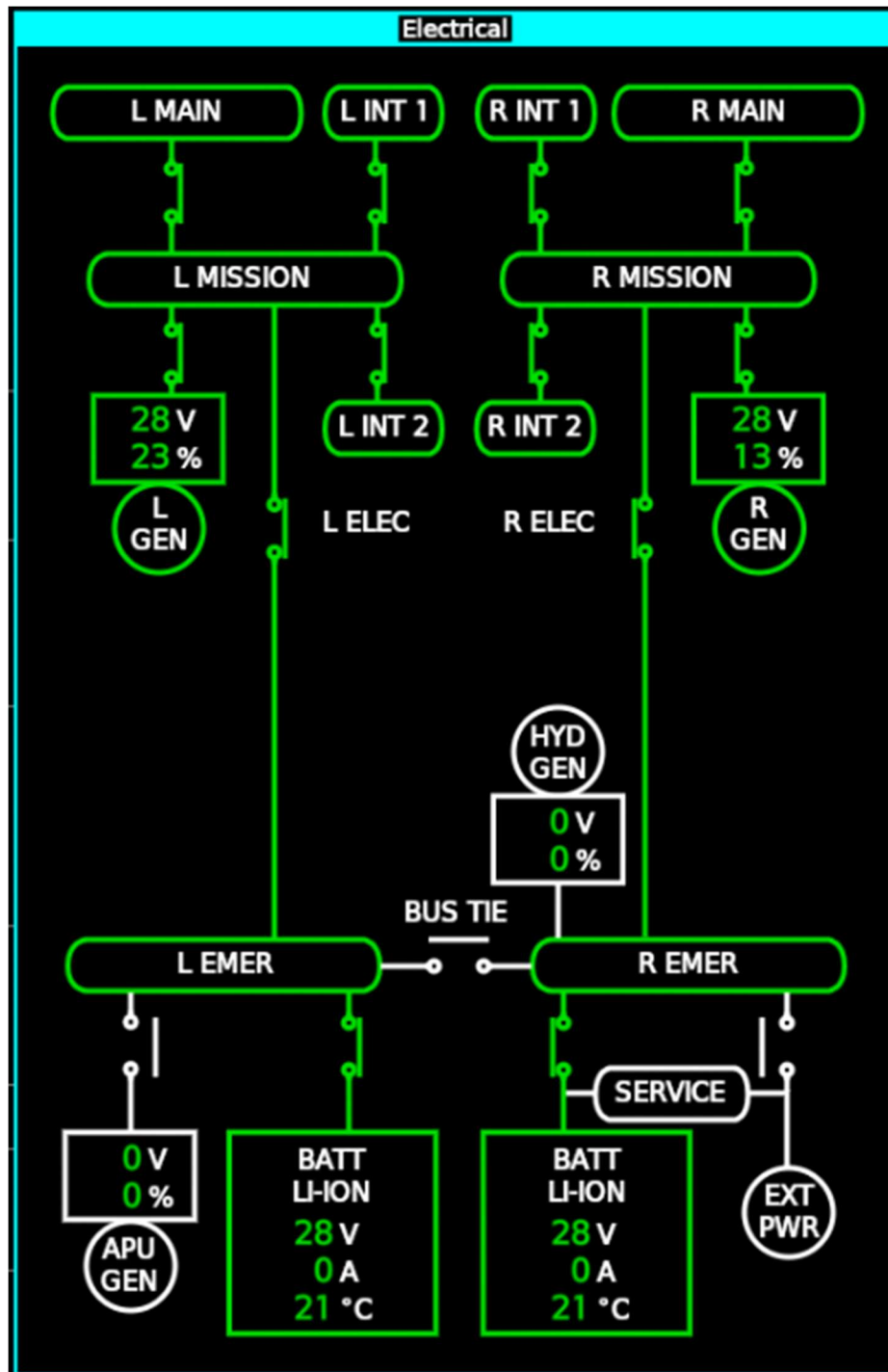


Fig 5-8-1 – Electrical Synoptics Pane

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VI - Fuel System

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Fuel System Overview

The Longitude fuel system consists of dual integral wing tanks which normally supply the on-side engine with fuel, as well as motive-flow ejector pumps, boost pumps, recirculation pumps, and a number of sensors. APU fuel is supplied by the right fuel tank.

Simulation Notes

The Longitude fuel system is built on the robust MSFS fuel system but also customized on top in a number of ways. All automation from the real aircraft is modeled, including automated boost pump management when in NORM modes, automatic recirculation pump management, fuel transfer valve logic, scavenge pump logic, and custom gravity crossflow simulation & logic.

In addition, a full fuel temperature simulation is included which considers things like wing skin temperature, the fuel mass, and fuel return temperatures to produce values consistent with real flight log data and to provide a realistic, authentic flight experience.

Wing Tanks

The wing tanks are of a wet wing design, integral into the structure of the wing. Each wing tank supplies fuel to its respective engine, while the right tank supplies fuel to the APU. Each wing tank has a usable fuel capacity of around 1080 US gallons.

Primary Ejector Pumps

The primary ejector pumps are the main means of transport of fuel to the engines during normal operations. Each ejector pump operated on high-pressure motive flow from the engines which in turn supplies fuel from the fuel tank hopper back to the engine fuel lines. The ejector pumps also provide motive flow to the fuel scavenge system.

Scavenge Ejector Pumps

Each wing contains scavenge pumps to move fuel from any low areas of the wing to the primary pump pickup areas. These pumps primarily run when fuel quantity is low to ensure fuel supply is maintained, but may also run when the fuel temperature is very low to assist in thermal circulation.

Fuel Boost Pumps

The fuel boost pumps are electrically driven, and provide fuel during operations where the ejector pumps may be insufficient or not running, such as during engine start (to prime the ejector pumps and main fuel system) or when fuel quantity is low. The fuel boost pumps are also utilized to transfer fuel through the fuel transfer valve.

As the APU cannot maintain a motive-flow pump, the right boost pump is utilized during APU operation.

Fuel Recirculation Pumps

The fuel recirculation pumps are on during all normal operations and circulate fuel through the wing to ensure that temperature control of the fuel mass is even and consistent. The fuel recirculation pumps will not run while the boost pumps are running.

Fuel Transfer Valve

The fuel transfer valve, in conjunction with a fuel boost pump, allows for fuel to be transferred from one wing tank to another. Because the fuel transfer valve is a single valve, attempting to transfer fuel with both fuel boost pumps active will push fuel in both directions, netting in zero fuel transfer.

Shutoff Valves

The left engine, right engine, and APU fuel shutoff valves control the flow of fuel to the respective turbines. The APU shutoff valve is normally closed and opens when the APU is in use.

Temperature Sensors

Two fuel temperature sensors, installed in each wing, read the temperature of the fuel in the tank and relay that to the computers and cockpit indications. Additionally, sensors provide fuel temperature readings for each main fuel inlet line.

Fuel System Controls



Fig 6-3-1 – Fuel System Controls



Fig 6-3-2 – Fuel Recirc Pump Control

L/R FUEL BOOST PUMP Buttons

The fuel boost pump buttons control the operational mode of the two fuel boost pumps. This momentary button has the following states:

- NORM (Cyan): The boost pump is in the automated NORM mode. In NORM mode, the fuel boost pump will automatically operate for engine start, fuel transfer operation, APU operation, and when fuel quantity is low.
- ON (Amber): The fuel boost pump is on.

When the fuel boost pump is on, whether by automatic logic or manually, the white FUEL BST PUMP ON L/R message will be triggered.

GRAVITY XFLOW Button

The gravity crossflow button controls the operation of the gravity crossflow valve which allows for gravity-based passive fuel transfer between tanks. This button has no effect on the ground, to prevent fuel flowing to the downhill wing tank. This momentary button has the following states:

- CLOSED (Cyan): The gravity crossflow valves are closed.
- OPEN (White): The gravity crossflow valves are open. Setting GRAVITY XFLOW to OPEN will trigger the white FUEL GRV XFLOW ON message.

FUEL TRANSFER Selection Knob

The fuel transfer selection knob controls the opening of the fuel transfer valve and the commanding active of the appropriate fuel boost pump for transfer. The fuel boost pump is used to pump fuel through the transfer valve to the opposite fuel tank. The knob has three positions:

- L TANK: Fuel is transferred from the right tank to the left tank. The right boost pump will be activated, and the fuel transfer valve will be opened.
- OFF: The fuel transfer valve is closed.
- R TANK: Fuel is transferred from the left tank to the right tank. The left boost pump will be activated, and the fuel transfer valve will be opened.

The white FUEL TRANSFER ON message will be triggered if either the L TANK or R TANK positions are selected. If fuel has been transferring for more than 10 minutes or if fuel is being transferred to a tank that has more than 60 pounds more fuel than the tank being transferred from, this message will become a yellow warning message.

A yellow **FUEL TRANSFER FAIL** message will be triggered if fuel is attempted to be transferred but both fuel boost pumps are currently active. This condition results in a net zero fuel transfer, as both pumps push fuel through the transfer valve.

FUEL RECIRC PUMP Button

The fuel recirc pump button controls the state of both fuel recirculation pumps. This is normally NORM but can be set to OFF if required by an AFM procedure. This momentary button has the following states:

- NORM (Cyan): The recirculation pumps are automatically controlled. Recirc pumps will be active under normal operations unless an on-side fuel boost pump is active or the fuel temperature is very low.
- OFF (White): The fuel recirculation pumps are commanded off.

Fuel System Indications

EIS Indications

The fuel system indications on the EIS display the total fuel quantity, the quantity of fuel in each engine, and the fuel tank temperature. Under the engine N2% the fuel flow will be displayed, in pounds. These digits will turn amber reverse video if the values are not within normal operating parameters.

If the fuel imbalance is greater than 500 pounds, the yellow **FUEL IMBALANCE** message will be triggered.

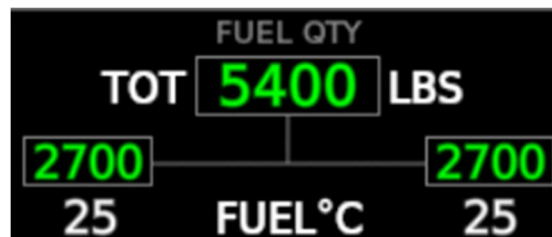


Fig 6-5-1 – EIS Fuel System Indications

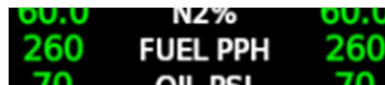


Fig 6-5-2 – EIS Fuel Flow Indication

Synoptics Indications

The Fuel synoptics pane displays an assortment of values and state relating to the fuel system. At the top are each tank level, with a value and bargraph indication, as well as tank temperatures and total fuel. The state of the gravity crossflow valves is also displayed at the top of the pane.

Recirc pumps appear at the top of each wing shape, with the boost pumps underneath and to the inboard. The motive-flow ejector pumps appear in the middle, with the scavenge valves to the inboard of the ejector pumps. The fuel transfer valve appears at the bottom center of the wing shape between each wing.

At the bottom of the pane appear the engine and APU icons, along with their associated fuel shutoff valves, as well as the fuel inlet temperatures. All digits on this pane will appear in amber reverse video if outside operating parameters. Flow lines are green when active and white when inactive.

If the inlet fuel temperature is less than +3C, the yellow **FUEL INLET COLD L/R** message will be triggered.

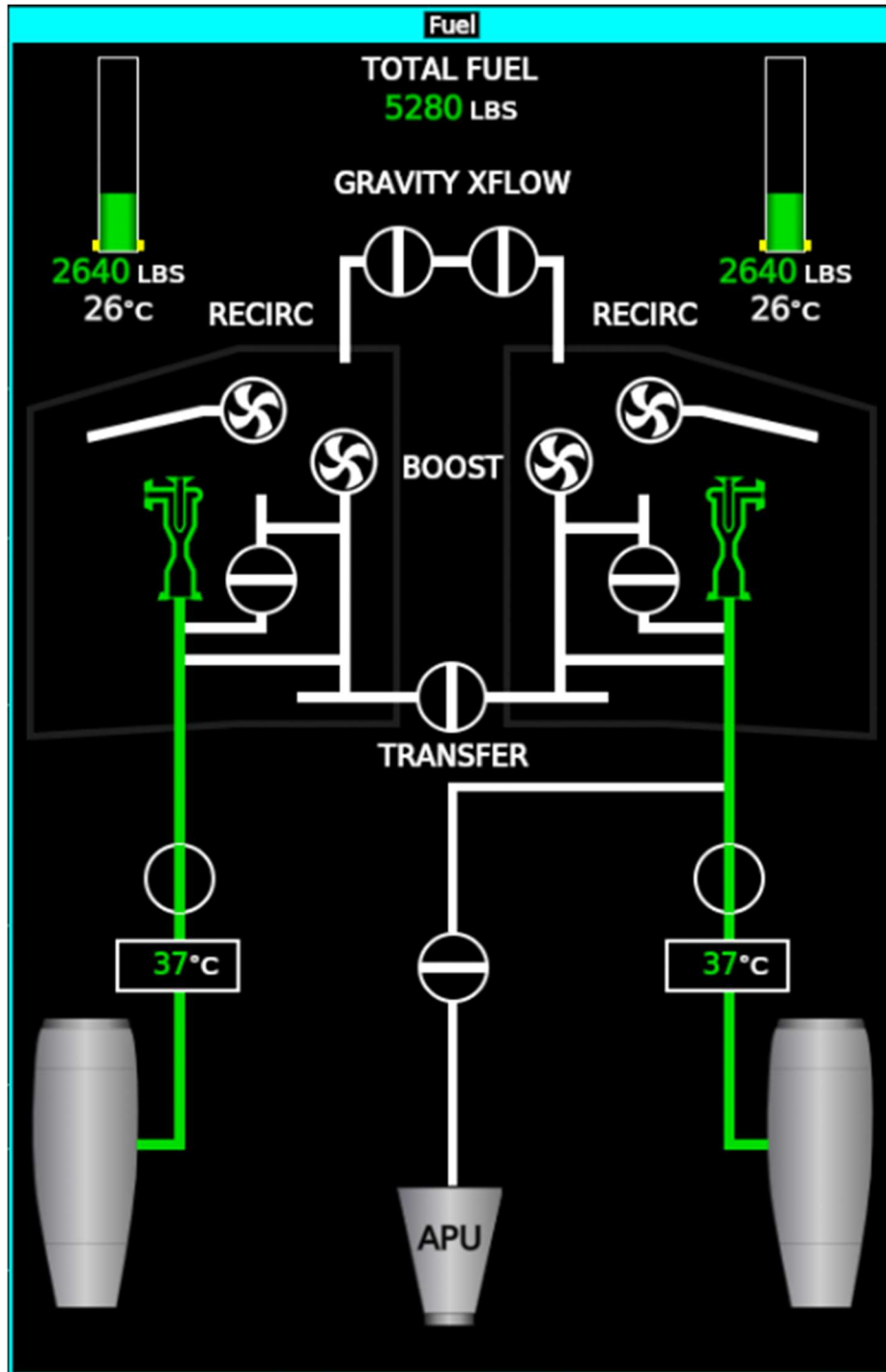


Fig 6-6-1 – Fuel Synoptic Pane

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Engines Description

The Longitude is powered by a pair of Honeywell HTF770L turbofan engines attached to the sides of the rear fuselage. Each engine is flat rated at 7,665lbs of thrust at up to ISA +18.9C. The engines also provide bleed air for pneumatics and environmental systems. Also attached are the hydraulic pumps and DC electrical generators. Each engine is controlled by a Full Authority Digital Engine Control system.

Simulation Notes

The custom engine simulation uses the MSFS turbine engine for all thrust, ITT, fuel flow, and oil, but builds on top of that solid foundation with a comprehensive simulation of the FADEC and autothrottle systems. The FADEC simulation includes all correct engine thrust modes; multiple flight data-matching N1 target maps for multi, single, and A/I on operation; correct auto-start and ignition logic, and more.

The autothrottle simulation is robust. All autothrottle modes are available including max and min speed protection modes, and a high quality control loop is implemented for accurate and authentic speed control response.

The engine flight model has been tuned for accurate speeds, climb rates, and fuel flows using book performance values.

Engines Overview

Full Authority Digital Engine Control (FADEC)

The FADEC computer engine control system continuously monitors the air temperature and pressure via internal sensors or ADC supplied values and via logic in the system will adjust ignition, thrust, engine synchronization, and other parameters. The FADEC is powered by an engine-integral alternator that will provide power any time the engine is running. Additionally, the FADEC has a number of modes of operation, which are displayed to the pilot on the instruments.

Air Turbine Starter (ATS)

The engine air turbine starter provides high pressure air for starting and motoring of the engine when bleed air is supplied. When the starter is engaged, the ATS valve is opened allowing this high pressure air to drive the starter, which is coupled to the engine via the accessory shaft.

Thrust Reverser

The Longitude engines contain a pivot door type thrust reverser which is hydraulically actuated. When activated, the thrust reverser directs thrust forward of the engine allowing for additional deceleration during landing rollout and a reduction in brake wear. The left thrust reverser is actuated from hydraulic System A and the right from hydraulic System B.

Engine Controls

The engine throttle quadrant contains all the relevant controls for managing the engines of the Longitude. Two large throttle levers provide throttle lever angle data to the FADEC, which schedules thrust based on

the position of the throttle levers. The throttle levers are continuous and have no detents; instead the FADEC will choose the appropriate thrust mode based on where the throttle lever is placed in the appropriate thrust mode range.

On the throttle levers are also the TO/GA arm button, which is to the outboard side of each throttle lever on the side of the handle. At the front of the handle near the handle and lever arm joint is the autothrottle disconnect button. On the outboard side of the throttle lever near the middle of the arm is the autothrottle arm button and housing, which faces aft.

Below the throttle area on the center pedestal are the ENGINE RUN/STOP buttons with safety covers as well as the ENGINE STARTER buttons.

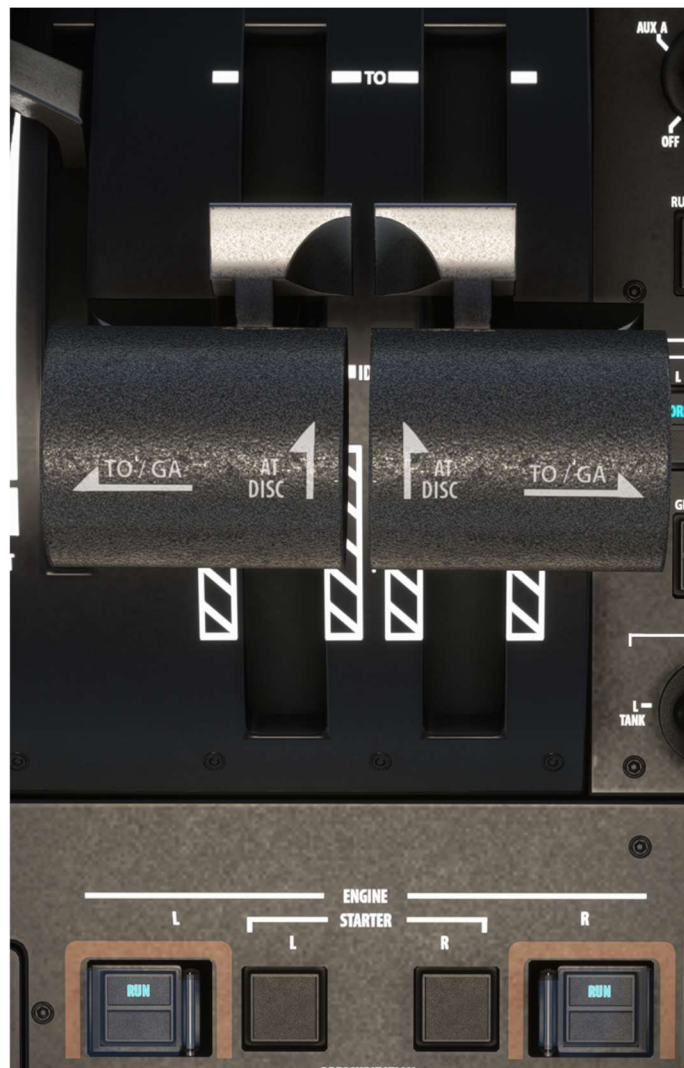


Fig 6-3-1 – Throttle Quadrant



Fig 6-4-1 – Location of the AT DISC buttons on front of handles (photo facing aft)



Fig 6-4-2 – Location of the TO/GA button (handle, left side) and AT arm button (handle arm, left side, facing aft)

Throttle Operations

Changing the engine throttle setting is accomplished by moving the throttles through the range. TO thrust mode is selected by moving the throttles fully forward, with CLB and CRU modes progressively further back along the throttle range.

Autothrottle Operations

The AT button at the rear of the throttle lever arm will arm/engage or disengage the autothrottle system. The autothrottle can also be disconnected using the button on the front of the throttle lever handles. The autothrottle mode is determined by the system and phase of flight. Target airspeed can be determined by the automation (using the FMS selection on the Speed Control knob on the autopilot panel) or manually (using the MAN selection on the same knob) by adjusting the knob up or down. The autothrottle has the

following modes, which are shown on the AFCS Status Box on the top of the PFD (white when armed, green when active):

- TO: The autothrottle is targeting takeoff thrust.
- HOLD: The autothrottle servos are disabled to allow throttle to be held in place during takeoff up to 400 feet AGL
- CLIMB: The autothrottle is targeting the FADEC CLB thrust mode.
- DESC: The autothrottle is targeting an idle thrust for descent.
- SPD: The autothrottle is targeting a set airspeed.
- RETARD: The autothrottle is reducing throttles to idle during landing operations below 40 feet AGL.
- MAX SPD: The autothrottle has engaged the max speed throttle protection mode and will limit throttle to prevent overspeed.
- MIN SPD: The autothrottle has engaged the min speed throttle protection mode and will increase throttle to prevent nearing stall speeds.

On the ground during takeoff and once the throttle is advanced towards takeoff power, the autothrottle will engage HOLD and disable the AT servos to prevent any autothrottle servo-induced power reductions during the critical takeoff operations phase. The pilots will see TO, however, when performing go-around operations at takeoff power, where HOLD is not active. HOLD will only activate when on the ground.

Engine Starting

Starting the engine is accomplished with the buttons located aft of the throttle quadrant on the center pedestal. The RUN/STOP button controls the FADEC engine run or stop state. The START button is a momentary button that operates in two modes:

- With the RUN/STOP button in STOP: Dry motors the engine while the start button is held. Once the button is released, the starter valve will close and the dry motoring will discontinue.
- With the RUN/STOP button in RUN: A press of this button will engage the automatic engine start sequence. The engine start sequence will continue until the start operation is complete. The button does not need to be held while the sequence proceeds, and will automatically disengage upon completion of the engine start sequence.

When the engine starter is active, the START button will light white. Start PSI indicated in the Start PSI box on the EIS should indicate 32 PSI or greater before attempting to engage the starter.

Engines may be started using APU bleed air or alternatively may also be started using opposite engine bleed air. Setting the RUN/STOP button to STOP while the engine is running will shut down the engine. Setting the button to STOP can also abort an engine start if desired.

The bleed air system automatically removes bleed air supply to the air conditioning system when an engine is starting, to ensure the engine air turbine starter has sufficient bleed air flow. If the left engine is started with both the right engine and APU running, the system will start the left engine via the APU only,

leaving the right engine to power the ACS during the engine start sequence. As such it is recommended to start the right engine first unless otherwise directed.

Engine Dry Motoring

After the engine is shut down, portions of the engine cool at different rates than other portions of the engine. This can lead to bowing of engine components. In order to prevent undue engine wear, an engine dry motor is recommended to be performed if an engine start is to be attempted 15 to 180 minutes after engine shutdown. If such a procedure is recommended, the white **ENG DRY MTR PROC L/R** message will be triggered. To perform an engine dry motor procedure:

- Ensure the RUN/STOP button is in the STOP position
- Ensure either APU or opposite engine bleed air is available and 32 PSI of pressure or greater shows in the Start PSI box
- Hold the START button for the engine to be dry motored for 15 seconds or up to 20% N2

After the dry motor procedure is complete, the **ENG DRY MTR PROC L/R** message will disappear after three minutes. When the message disappears, the engine may be started.

Dry motor and shutdown times can be checked in the Summary synoptics pane, accessed via the Systems page on a MFD GTC.

Engine Indications

Important engine operating parameter indications are displayed on the EIS in the top left corner. These indications include N1%, ITT, N2%, fuel flow, oil pressure, and oil temperature.

EIS N1% Indicator

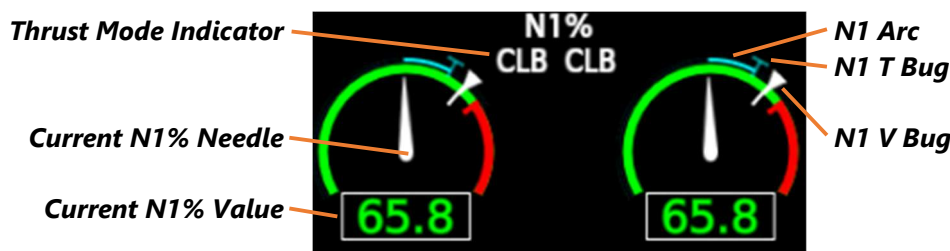


Fig 6-5-1 – EIS Engine N1 Indicators

The N1 Indicator presents a large amount of data regarding the speed of the engine, engine speed targets, and other FADEC values. The green arc is the normal operational range of the engine, with the red portion of the arc indicating the engine exceedance range. The current N1% needle and the N1% value display the current engine N1 speed.

The N1 T bug is the currently selected thrust corresponding to the throttle lever angle, with the N1 Arc indicating the delta between the current engine speed and the desired engine speed. The N1 V bug indicates the engine speed corresponding to the current FADEC thrust mode. The N1 Arc and T bug are cyan when pilot selected, green when pilot selected and matching a FADEC thrust mode, and magenta when under autothrottle control. The N1 V bug is white when the pilot selected speed does not match a

FADEC thrust mode, green when the pilot selected engine speed is matching, and magenta when under autothrottle control.

The thrust mode indicator shows the current FADEC thrust mode:

- TO: Takeoff
- CLB: Climb
- CRU: Cruise
- APR: Automatic Power Reserve
- T/R: Thrust Reverse

Thrust Reverser Indications

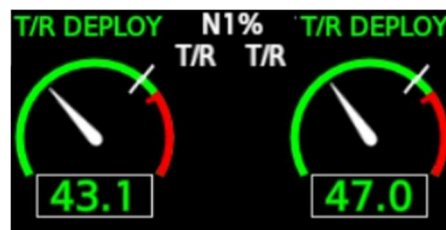


Fig 6-6-1 – EIS N1 Indicator with thrust reverser indications

Thrust reverser indications appear at the top of the N1 indicator, and show the following possible states:

- T/R UNLOCK: The thrust reverser has been unlocked and is deploying.
- T/R DEPLOY: The thrust reverser is deployed and locked in the deployed position.

EIS Engine Start Indications

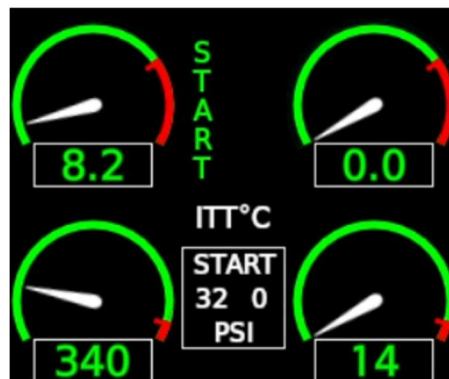


Fig 6-6-2 – EIS Engine start indications

Prior to both engines running, the starter PSI start box will appear between the ITT gauges. This shows the amount of pressure available at the ATS starter valve for engine start. PSI for engine start should be at least 32 PSI. Additionally, START will appear vertically while the engine FADEC is performing the engine start procedure.

EIS ITT Indicator

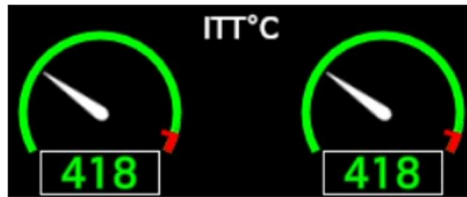


Fig 6-7-1 – EIS Engine ITT Indicators

The EIS ITT indicators are located under the N1 indicators. The green arc indicates the normal operating range, with the red arc indicating the unsafe operating range. The needle shows the current engine ITT and the numeric value is also shown, prior to engine start. Once the engine is started, the ITT numeric value is removed from the display. The pilot may show the ITT digits by using the Systems Propulsion page on the GTC and enabling Engine Display Digits.

The red unsafe range lowers to the hot start range during start, and returns to the normal range after the engine is started.

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Auxiliary Power Unit Description

The Longitude is equipped with a Honeywell Model 36-150[EMB] turbine powered auxiliary power unit. This APU is designed for unattended operation. The APU provides both electrical power and a source of bleed air for pneumatics and environmental systems.

The APU is also certified for use in flight up to FL350. The maximum altitude for starting the APU while in flight is FL310.

Simulation Notes

The Longitude APU uses the standard MSFS APU simulation plus a custom APU EGT simulation, but then feeds and is affected by the custom bleed air and fuel system simulations.

APU Fuel

Fuel for the APU is sourced from the right fuel tank. As the APU does not have enough flow to power the motive-flow ejector pumps, the right fuel boost pump is engaged when starting and operating the APU. If the right engine is running, the boost pump is no longer required and will turn off.

APU Controls

The APU is controlled by a single three position knob, located in the aft right corner of the center pedestal. This knob has the following positions:

- OFF: The APU is powered off.
- ON: The APU is running.
- START: The APU start sequence will begin. This is a momentary spring loaded position and will return to the ON position.

A white **APU ON** message will be triggered if the APU is on above FL200. A yellow **APU ON** message will be triggered if the APU is on above the maximum certified usage altitude of FL350.

NOTE:

Bleed air will not be provided until 90 seconds after the APU is started..



Fig 6-2-1 – APU Controls

APU Indications

The APU indications appear on the lower right corner of the EIS and include the RPM as a percentage and APU EGT. The APU is automatically controlled so that 100% RPM is maintained as APU load changes. A white APU OFF replaces the RPM and EGT displays when the APU is not running.

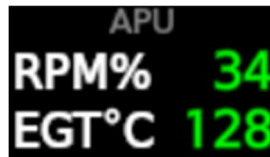


Fig 6-3-1 – APU EIS Indications

APU Hours and Cycles for the current airframe are displayed on the Propulsion page, accessed via the Systems page on a MFD GTC. The Longitude saves this information per individual airframe, which is determined by the tail number chosen.



Fig 6-3-2 – APU Hours and Cycles indication on the Propulsion page

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Pneumatic System Description

The Longitude contains a comprehensive pneumatic system that powers a number of important areas, including cabin pressurization, environmental control, the air turbine starters, and anti-ice systems. Bleed air for the pneumatic systems is sourced from the engines or APU. Ground pneumatic source is not modeled.

Engine bleed air may be taken from either the high pressure (HP) source (from the engine high-stage compressor), low pressure (LP) source (from the engine intermediate-stage compressor), or both. If the LP source is sufficient for the current operational settings, the HP source is not used, to increase engine efficiency.

Simulation Notes

The Longitude includes a fully custom and comprehensive bleed air system built from the ground up for this aircraft. The bleed air system is fully flow based, and computes pressures and temperatures in real-time from valve and line conditions as well as LP and HP source contributions at various engine speeds. Bleed air routing will affect the air conditioning and anti-ice systems in correct ways. Engine performance changes based on bleed air load are also modeled, such as N1 drop, ITT rise, and decreased fuel efficiency.

Additionally, the full array of complex Longitude bleed air automation logic found on the real aircraft is faithfully represented here.

Pressure Regulating Shutoff Valves (PRSOVs)

Each engine contains two PRSOVs, one for each bleed air stage. The LP source will normally supply the bleed air requirements for all connected systems, unless the pressure provided is less than the HP regulation point. When the pressure provided by the LP bleed falls below this point, the HP PRSOV will open and the HP bleed will also provide bleed air to the connected systems.

The HP regulation point is normally set at 31.5 +/- 2.5 PSIG, however it will shift to 52 +/- 6 PSIG when wing anti-ice is requested, in order to satisfy the higher wing anti-ice bleed air requirements.

Bleed PRSOVs

The bleed PRSOVs control the flow of the engine bleed air to the main bleed air manifold. These valves are controlled electronically, and when signaled open, will open only with pressure beyond 12 PSIG in order to ensure that the bleed air sources are stable before attempting to supply bleed air.

APU Shutoff And Check Valves

The APU shutoff valve is similarly electronically controlled, and when signaled open will open when the APU bleed air pressure is sufficient for the supply. In combination with the APU check valve these also prevent bleed air flow in the wrong direction.

Bleed Air Isolation Valve and Wing XFlow Valve

The bleed isolation valve is used to isolate the two halves of the bleed air system, or to couple the sides if desired or required. When the bleed isolation valve is open, the two sides of the main bleed air manifold are connected and bleed air sources from either side of the manifold can be used to power all pneumatically powered systems. In addition, a wing-only crossflow valve allows for left-only or right-only sourcing of heated bleed air to both wing leading edges while avoiding coupling the main bleed air manifold to ensure adequate wing anti-ice bleed air.

Bleed Air Controls

The bleed air controls are located at the rear of the center pedestal, in the middle control section to the aft of the environmental controls.

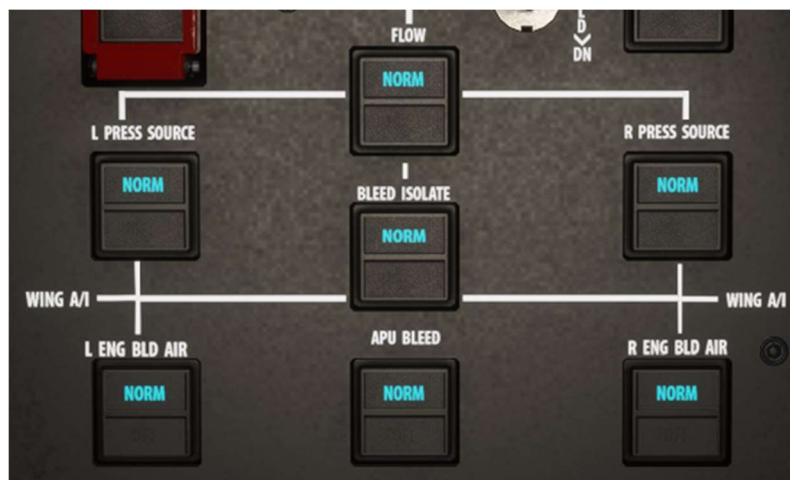


Fig 9-3-1 – Bleed Air Controls

L/R ENG BLD AIR Buttons

The L and R ENG BLD AIR buttons control the flow of bleed air from the engines to the bleed air system. These momentary buttons have two possible states:

- **NORM (Cyan):** Control of the bleed air source is automatic. The bleed air source will flow to the main manifold under almost all operational conditions. Bleed valves may close during some engine start conditions to provide maximum bleed air to the ATS while preventing bleed draw to the opposite engine.
- **OFF (Amber):** The engine bleed air source is turned off. A yellow **ENG BLEED OFF L/R** message will trigger, if on the ground. This message will be white if in the air.

APU BLEED Button

The APU BLEED button controls the flow of bleed air from the APU to the left bleed air manifold. This momentary button has two possible states:

- NORM (Cyan): Control of the APU bleed air source is automatic. Bleed air will flow from the APU to the left bleed air manifold. Bleed air is provided 90 seconds after the APU is started.
- OFF (Amber): The APU bleed air source is turned off. The APU bleed air PRSOV will be signaled closed. A yellow **APU BLEED OFF** message will trigger, if on the ground. This message will be white if in the air.

BLEED ISOLATE Button

The BLEED ISOLATE button controls both the main bleed air manifold bleed isolation valve as well as the wing crossflow valve. This momentary button has two possible states:

- NORM (Cyan): Control of the bleed isolation and wing crossflow valves is automatic. The bleed isolation valve will be commanded closed except during engine start operations where bleed air must be sourced from the opposite side of the manifold. If the aircraft is in the air and an engine has been shutdown for more than two minutes or if the aircraft is in the air and an engine is being started, then a yellow **BLEED ISOLATE NORM** message will be triggered to alert the pilots that they should select cross flow of the bleed system.
- XFLOW (White): The bleed isolation valve is commanded open, unless wing anti-ice is requested. If wing anti-ice is requested, the bleed isolation valve will remain closed and the wing crossflow valve will open instead. A white **BLEED ISOLATE XFLOW** message will be triggered. This message will become yellow if throttles are advanced to takeoff on the ground or if both engine bleed air sources are available and XFLOW has been selected for more than 5 minutes.

L/R PRESS SOURCE Buttons

The L and R PRESS SOURCE buttons control the flow of bleed air from the on-side manifold half to the environmental control system and pressurization system. Additional description of these buttons as they relate to those systems can be found in their respective operator's guide sections.

FLOW Button

The FLOW button controls whether the bleed air system is in a normal or high flow mode. This primarily affects the environmental control system. More details can be found in the respective operator's guide section.

Bleed Air Indications

ECS and Anti-Ice Synoptics

Indications for systems connected to the pneumatics are displayed on the ECS synoptics pane and the Anti-Ice synoptics pane, accessible via the Systems page on a MFD GTC. The ECS pane shows the flow of bleed air into the environmental control system, and the Anti-Ice synoptics pane shows the flow of bleed air into the wing and engine anti-ice systems. The separate HP and LP valves appear on the Anti-Ice synoptic. There are no display indications for the main bleed air manifold path to the air turbine starters.

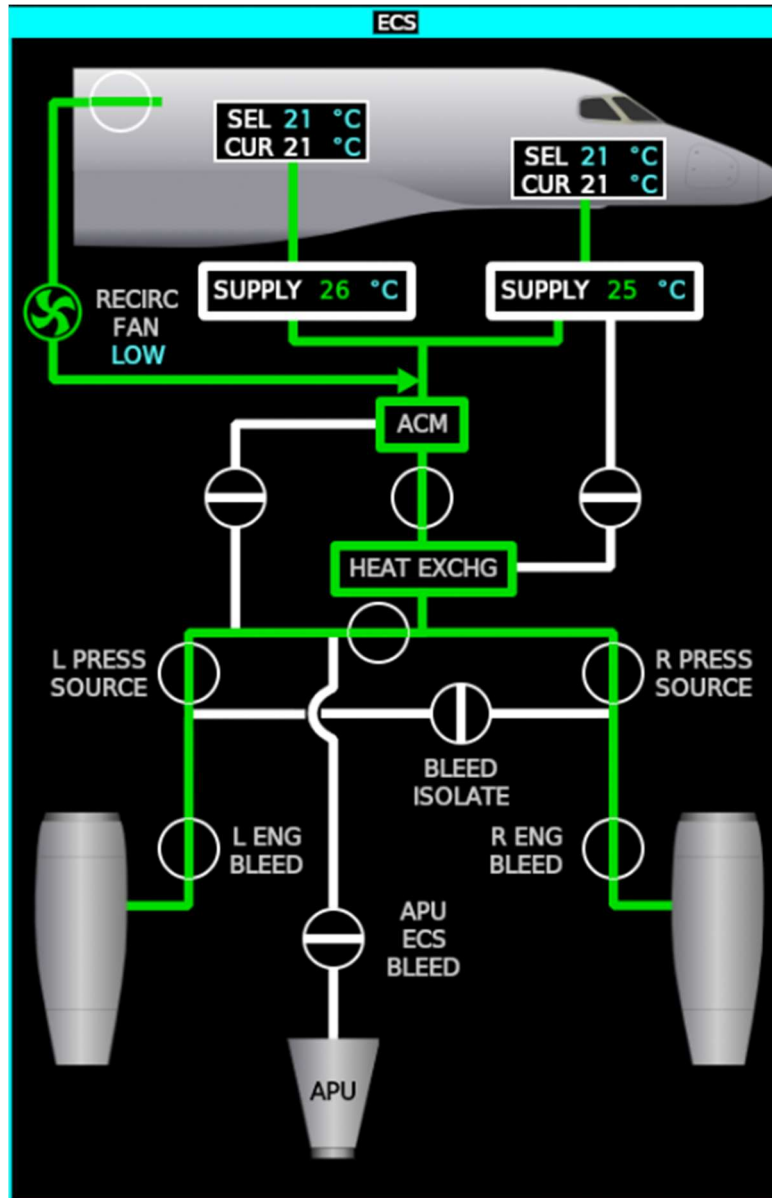


Fig 9-5-1 – ECS Synoptic Pane



Fig 9-6-1 – Anti-Ice Synoptic Pane

Pre-Flight Synoptic

The Pre-Flight synoptic pane, accessible through the Systems page on a MFD GTC, shows the status of both power-on pneumatic derived tests and taxi tests. These tests are described in more detail in the Crew Alerting System operator's guide section.

POWER ON		
BLEED LEAK		PASS
CVR		PASS
FLAPS		PASS
FUEL LEVEL LOW		PASS
ICE DETECTION		PASS
PRESSURIZATION		PASS
TAXI		
SPOILERS		PASS
TAIL DE-ICE		PASS
WING ANTI-ICE		PASS
PROBE/CASE HEATERS		PASS

Fig 9-7-1 – Some pneumatic relevant tests (bleed leak, pressurization, wing anti-ice)

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X – Air Conditioning

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Air Conditioning Description

The Longitude Air Conditioning System (ACS) provides the cabin and cockpit with climate-controlled air, ensuring optimal passenger comfort, cockpit visibility, and safety. Air is continuously fed into the cabin via bleed air from the ACS and exits the cabin via the cabin pressurization system valves. The ACS consists of an Air Cycle Refrigeration Pack (ACRP) and associated components that take engine and APU bleed air and condition it for usage in the cabin and cockpit environments.

Simulation Notes

The Longitude includes a full simulation of the ECS and air conditioning systems. This includes ACM and Heat Exchanger only modes, with appropriate cabin and heating capacities and capabilities. The bleed air system simulation is fed into the air conditioning simulation, providing temperature simulation for the pack source outlets, realistic heat transfer to and from the interior air mass, all able to be managed by an automated temperature controller.

Air Cycle Refrigeration Pack (ACRP)

The ACRP is primarily composed of two high level units: a series of heat exchangers and an Air Cycle Machine (ACM). The ACRP is capable of delivery a wide temperature range of conditioned air to provide excellent cabin heating and cooling performance.

Primary and secondary heat exchangers are within the ram air flow and remove heat from the bleed air source prior to reaching the ACM. The ACM cools the air via standard compressor-based refrigeration and the secondary heat exchanger will remove the hot compressor air.

In case of a leak, both the heat exchangers and ACM can be isolated from the bleed air flow. Doing so can impact the performance of the heating and cooling of the cabin. If the heat exchanger is selected as the sole air conditioning source, the system will be unable to cool the cabin lower than the current RAT.

Air Conditioning Controls

The air conditioning controls are primarily located directly aft of the engine starter button area on the center pedestal.



Fig 10-3-1 – Air conditioning controls

CABIN/CKPT TEMP Knobs

The CABIN and CKPT TEMP knobs control the temperature of the cabin and cockpit source ducts that exit from the ACRP. When the knobs are in NORM, the temperature exiting the ducts is controlled by the cabin temperature controller to regulate the cabin and cockpit temperatures to the values selected on the GTC Temperature Page. The selected cabin and cockpit temperatures will be maintained by the temperature controller.

When the knobs are moved to the manual range, the cabin and cockpit supply duct temperature is controlled by the knob position. The cabin and cockpit selected temperature will not be automatically maintained and must be managed by increasing or decreasing the supply temperature to reach the desired cabin and cockpit temperatures.

ECS Knob

The ECS knob controls the isolation mode of the ACRP. The knob has three positions:

- **NORM:** The ACS is controlled by the temperature controller and targets the temperature on the GTC Temperature Page. Bleed air will pass through both the heat exchangers and the ACM for best ACS performance.
- **ACM ONLY:** The heat exchangers will be bypassed, and the ACS will operate via the ACM only. When the knob is in this position and the aircraft is on the ground, the yellow **ACM ONLY** message will be triggered.
- **HEAT EXCHG ONLY:** The ACM will be bypassed, and the ACS will operate via the heat exchangers only. When the knob is in this position the white **HEAT EXCHG ONLY** message will be triggered. This message will become yellow if the airplane is on the ground or if the system has automatically switched to heat exchanger mode and the knob is not in this position.

FLOW Button

The flow button controls the flow mode of the bleed air system to the ACS. This momentary button has two possible states:

- NORM (Cyan): Normal airflow volume will be provided to the ACS.
- HIGH (White): Increased airflow will be diverted and provided to the ACS system to increase heating and cooling performance. Selecting HIGH on very warm or very cold days is recommended to maximize climate control rates.

L/R PRESS SOURCE Buttons

The L and R PRESS SOURCE buttons control the flow of bleed air from each side of the main bleed air manifold into each side of the ACS manifold. Bleed air flow into the ACS system is required for heating, cooling, and cabin pressurization. These momentary buttons have two possible states:

- NORM (Cyan): The pressure source valves will be automatically controlled. These valves are normally open to provide flow to the ACS, except during some engine start operations.
- OFF (Amber): The pressure source valves will be closed. No bleed air will flow from the on-side main manifold to the on-side ACS manifold.

GTC Temperature Page

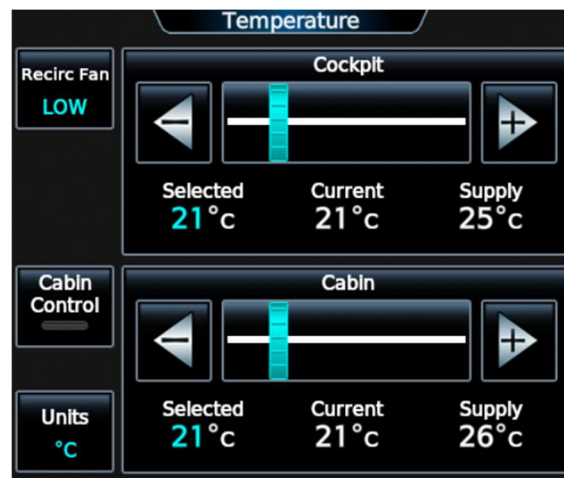


Fig 10-4-1 – GTC Temperature Page

The GTC Temperature Page allows the pilots to select the target temperature for the cockpit and cabin climate control zones. Additionally, the recirc fan speed may be controlled from this page. Pressing the Units button will allow one to change between C and F units, which will also be reflected on the ECS synoptic page. The cabin control button will allow the passengers to control the cabin temperature, but has no effect in the sim at this time.

For very warm days, selecting the coldest possible target temperature will expedite the cabin and cockpit cooling process. Conversely, for very cold days, selecting the warmest possible target temperature will expedite the heating process.

APU and the Air Conditioning System

The APU is specified to produce 100% of its maximum ACS performance via bleed air when in High Flow Mode, and 60% in Normal Flow Mode. Once the APU is started, it will take 90 seconds for bleed air to be supplied to the ACS. Bleed air is being supplied once the ACS airflow can be heard and felt through the cabin vents.

ACS During Engine Start

The bleed air system automatically removes bleed air supply to the ACS when an engine is starting, to ensure the engine air turbine starter has sufficient bleed air flow. If the left engine is started with both the right engine and APU running, the system will start the left engine via the APU only, leaving the right engine to power the ACS during the engine start sequence.

As such it is recommended to start the right engine first unless otherwise directed.

ACS Indications

The state of the air conditioning system is displayed on the ECS synoptic pane. This pane shows the flows of the bleed air system sources into the air conditioning system and the position of various bleed air valves related to the ACS. Active flows are colored in green, and inactive flows in white.

The cabin and cockpit supply temperatures are also depicted, as well as the current temperatures in each zone, and the selected target temperature for each zone, displayed in the units selected on the GTC Temperature page. Recirc fan speed and activity is also shown.

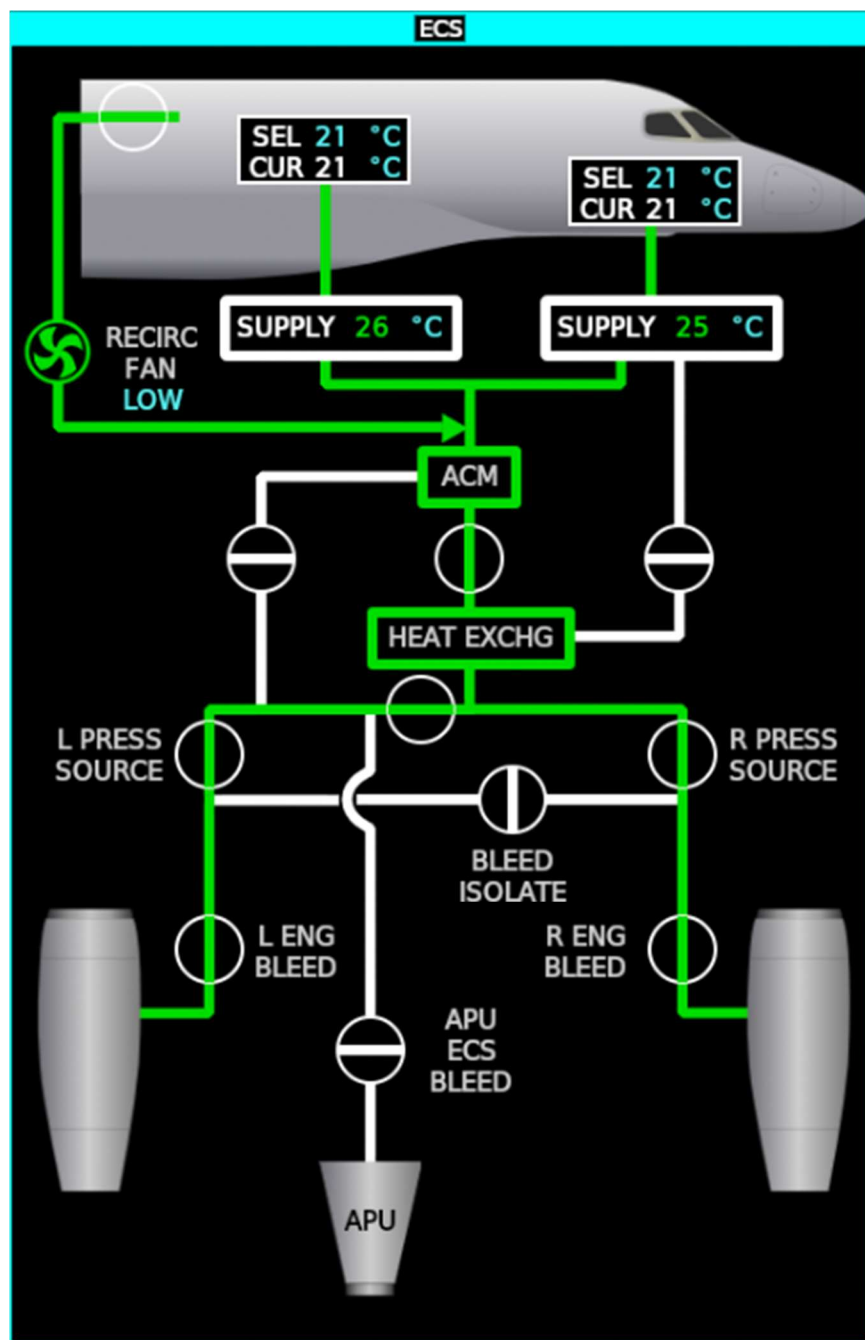


Fig 10-5-1 – ECS Synoptic Pane

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XI – Pressurization

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Pressurization Description

The Longitude is equipped with an automated electronically controlled Cabin Pressurization Control System (CPCS) that regulates the cabin altitude for maximum pilot safety and passenger comfort. The system can provide a cabin altitude of just 5,950 +/- 225 feet at FL450. Pressurized ACS air is continually added to the pressure vessel, and an electronically actuated outflow valve controls the rate at which air leaves the pressure vessel.

Simulation Notes

The Longitude includes a very complete simulation of the pressurization system found on the real aircraft. It includes all the various modes, such as climb, descent, manual, high alt, and uses accurate cabin altitude schedules to provide a very authentic facsimile. The climb and descent rates are likewise accurate to the real aircraft, taking into account the current modes and conditions.

The simulation is also affected by the bleed air system as it should be, and preventing bleed air from reaching the ACS will likewise prevent additional cabin pressurization. Smaller details like the negative pressure relief system are also modeled.

Cabin Pressurization Controller and Systems

The cabin pressurization control monitors the current aircraft altitude, ambient pressure, and internal pressure to schedule a comfortable target cabin altitude by adjusting the position of the cabin outflow valve. The controller uses multiple target cabin pressure schedules and modes to achieve these cabin altitude targets.

Ground and Takeoff Modes

While on the ground, the controller will fully open the outflow valve so the cabin remains unpressurized. When the throttles are advanced to takeoff power, the controller will begin closing the outflow valve and command a descent to around 200 feet below the field elevation, to prevent cabin pressure fluctuations during the takeoff operation.

Climb and Descent Modes

Once the aircraft is airborne, the controller will enter the climb mode, using a predetermined schedule to target a cabin altitude that is as low as possible while still maintaining reasonable cabin altitude change rates. Descent mode is entered once the aircraft descends 500 feet from a held altitude. If the aircraft begins to climb again, climb mode will be re-entered.

Landing Mode

The pressurization controller will target 200 feet below the landing elevation as the final cabin altitude to reach during the descent. Once the aircraft is on the ground, the cabin will automatically be depressurized at a rate of 500 feet per minute if the delta P is 0.3 PSI or less, or 2000 feet per minute if it is greater.

High Altitude Mode

In order to accommodate airfields that are higher than the planned max cabin altitude of 5,950 feet, the pressurization controller can also enter a high altitude mode. If the departure or destination airfield elevation is greater than 8,000 feet, the controller will enter this mode. In this mode the cabin may actually need to climb during the descent to reach the destination airfield altitude (if the destination airfield is high) or opt for a higher than usual cabin descent rate to reach a safe cabin altitude by FL245 (if the departure airfield is high).

Controller Crew Alerts

- Cabin Delta P: When the cabin delta P is greater than 10.2 PSI a red **CABIN DELTA P** message will be triggered.
- Cabin Altitude:
 - Normal: A yellow **CABIN ALTITUDE** message will be triggered when the cabin altitude exceeds 8,500 feet. This message will become red when the cabin altitude exceeds 9,800 feet.
 - High Alt Mode: A white **CABIN ALTITUDE** message will trigger to alert the pilots to the altered cabin altitude schedule. This message will become yellow when the cabin altitude has exceeded 9,800 feet for more than 30 minutes. Additionally, this message will become yellow when the cabin altitude exceeds 14,800 feet.

Pressure Relief Valve

The pressurization system contains a pressure relief valve to prevent the cabin from experiencing an overpressure event. When the maximum cabin delta P is exceeded this valve is held open against a spring via pressure action, allowing pressure to be released from the cabin.

Negative Pressure Relief Valve

While the cabin altitude controller normally has the capacity to prevent negative delta P, the Longitude per regulations also contains a negative pressure relief valve, which allows ram air to flow into the cabin if the cabin is at a negative delta P.

Operational Considerations

Bleed air flow to the ACS is required to pressurize the cabin. As such, if bleed air is disconnected from the ACS, cabin pressurization will not continue, and the current cabin pressure will be held. This may result in a rise in cabin altitude.

Pressurization Controls

GTC Cabin Pressure Page

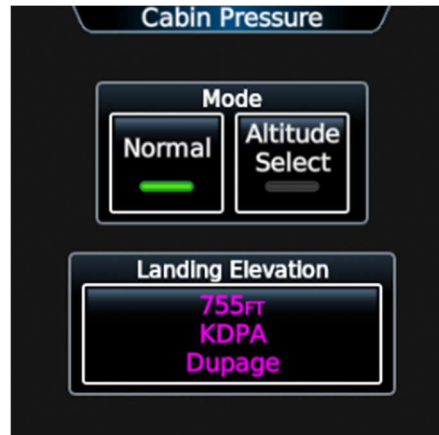


Fig 11-4-1 – Cabin Pressure GTC Page

The Cabin Pressure page is the primary means of managing the pressurization system, and is accessed via the Systems page on a MFD GTC. The page has a few buttons and options.

The Mode buttons allow the pilots to select the mode the controller should be operating in.

- Normal: The controller will target a landing elevation and use the climb and descent schedules to automatically manage the cabin altitude. This landing elevation can either be FMS controlled (targeting the destination) or manually entered.
- Altitude Select: The controller will target exactly the altitude entered in the Cabin Altitude selection box.

The Landing Elevation/Cabin Altitude box allows the pilot to adjust either the landing elevation or cabin altitude. When the box is in landing elevation mode, pressing this button will bring up the landing elevation dialog. In this dialog, a manual landing elevation can be entered. Alternatively, pressing Use FMS Destination will close the dialog and switch to using the destination entered in the FMS flight plan.

When the box is in Cabin Altitude mode, pressing this button brings up the cabin altitude dialog. Entering an altitude here will instruct the controller to target this exact cabin altitude.

Pedestal Controls

The additional pilot controls for cabin altitude are located on the center pedestal, aft of the environmental controls.

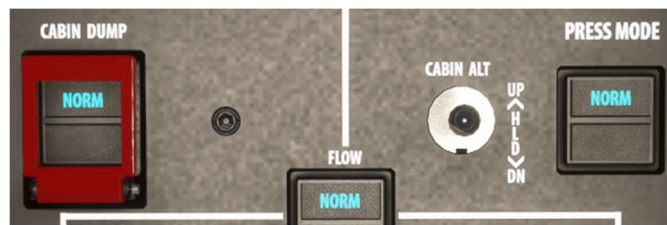


Fig 11-4-2 – Cabin Altitude pedestal controls

Cabin Dump Button

The cabin dump button controls the emergency cabin pressure dump function. This button has a guard that must be moved in order to prevent the button from inadvertently being pushed. This momentary button has two states:

- NORM (Cyan): The cabin pressurization dump function is not engaged.
- DUMP (Amber): The cabin pressurization dump function is engaged. The cabin outflow valve is fully opened, and cabin pressure will rapidly equalize with the ambient external pressure.

PRESS MODE Button

The PRESS MODE button controls the current pressurization controller mode. This momentary button has two states:

- NORM (Cyan): The cabin pressure is automatically managed via the cabin pressurization controller using the options set on the GTC Cabin Pressure page.
- MANUAL (Cyan): The cabin pressurization controller is bypassed. Cabin altitude is controlled via the CABIN ALT switch to the left of the PRESS MODE button.

CABIN ALT Switch

The CABIN ALT switch controls the current cabin altitude when PRESS MODE is MANUAL. The switch is a momentary switch and must be held in the UP or DN position. When holding the switch, the cabin altitude moves up or down (depending on the direction held). The cabin holds its current pressure when the switch is centered.

NOTE:

The CABIN ALT switch changes pressurization slowly for the first 6 seconds it is held. After 6 seconds, the outflow valve is rapidly repositioned, and the pressurization change is very fast. Use small, short changes when using this switch unless a rapid change is necessary.

L/R PRESS SOURCE Buttons

While these buttons are not within the cabin controls area, they do control bleed air flow to the ACS, which is required for pressurization. More information on these buttons can be found in the section on the Air Conditioning System.

Pressurization System Indications

EIS Pressurization Display

The cabin pressurization system indications show on the bottom right of the EIS. The cabin altitude is normally displayed in green, but will turn yellow or red based on the same altitude and controller conditions as the CABIN ALTITUDE message. The current cabin altitude change rate is displayed underneath the cabin altitude.

On the opposite side, either the landing elevation (LDG ELEV) or the selected cabin altitude (ALT SEL) is displayed. User selected values will appear in cyan and FMS derived values in magenta. Under the elevation the cabin delta pressure is displayed. The value digits are green, unless the delta pressure is exceeding the limits, upon which the digits will become red.



The image shows a digital display with two columns of information. The left column is headed 'CABIN ALT' and shows '750 FT' in green, with '0 FPM' in green below it. The right column is headed 'LDG ELEV' and shows '755 FT' in magenta, with 'ΔP 0.0 PSI' in green below it.

CABIN ALT	LDG ELEV
750 FT	755 FT
0 FPM	ΔP 0.0 PSI

Fig 11-6-1 – Cabin pressurization EIS display

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XII – Ice and Rain Protection

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Ice and Rain Protection Description

The Longitude is equipped with a robust ice protection system that provides anti-icing for the critical equipment and flight surfaces of the aircraft. The wing leading edges and the engine inlet areas are heated by bleed air, and the horizontal stabilizer is de-iced via an electromechanical system. Electrical heating provides protection to other instruments such as the pitot-static and windshield. Windshield heating is fully automatic.

The Longitude is approved for operation in maximum intermittent and maximum continuous icing conditions as defined by 14 CFR Part 25, Appendix C, when all ice protection equipment is in operational condition.

Simulation Notes

The Longitude anti-ice system utilizes the MSFS icing simulation to drive the accumulation, aerodynamic effects, and ice removal (from the sim side), but adds a simulation of the wing anti-ice system, the windshield heat controller, and automated pitot heat system.

A number of real aircraft behaviors are modeled, such as engine spool and wait prior to opening the wing anti-ice valves, pitot logic, ice detectors, and more. The stabilizer anti-ice button is modeled, but no behavior is connected and it will not affect ice accumulation due to sim limitations.

Ice Detectors

There are twin ice detectors equipped on the Longitude, located on either side of the nose below the windshields. The Longitude does not require activation of the ice protection systems at typical cruise speeds until the ice detectors detect icing conditions. When icing conditions are detected the yellow **ICING** message will appear in both the CAS and in the EIS.

Wing Inspection Light

The Longitude is equipped with wing inspection lights mounted to the left and right sides of the fuselage to aid in illuminating the wing leading edges for inspecting for ice accumulation during nighttime operations.

Wing Anti-Ice

The wing anti-ice system uses heated bleed air from the engines to warm the leading edge of the wing surface, by routing the hot bleed air through the wing to piccolo tubes installed inside the wing leading edge. Temperature probes installed in this area monitor the leading edge temperature and display that information to the pilots.

Engine Anti-Ice

The engine anti-ice system also uses heated bleed air directly from the engines themselves to heat the inlet leading edge via piccolo tubes.

Windshield Heat and Rain Protection

The windshield anti-ice system consists of an automated electrically heated set of windshield panels. A windshield heat controller keeps the windshield panels at 40-45C to prevent ice accumulation and surface fogging.

The Longitude is not equipped with windshield wipers. The windshields are coated in a hydrophobic coating that prevents rain accumulation.

Ice Protection System Controls

The ice protection controls are located on the co-pilot side lower panel, underneath the PFD.



Fig 12-3-1 – Ice Protection Controls

L/R ENGINE Buttons

The L and R ENGINE buttons control anti-ice heat application to the engine inlet leading edge. These momentary buttons have the following states:

- OFF (Cyan): No anti-ice bleed air heat is applied.
- ON (White): Anti-ice bleed air is diverted from the engine and applied. This will trigger a white **A/I** **ENG ON L/R** message. If all four top anti-ice buttons are ON, this message will become **ICE PROTECT ALL ON**.

WING Button

The WING button controls anti-ice bleed air application to the wing leading edge surfaces. This momentary button has the following states:

- OFF (Cyan): No anti-ice bleed air heat is applied.
- ON (White): Anti-ice bleed air is applied to the wing leading edge surface. When activating wing anti-ice, engines will spool slightly for 4 seconds before the wing anti-ice bleed valves are opened in order to prepare for the increased bleed load. This will trigger a white **A/I WING ON L/R** message. If all four top anti-ice buttons are ON, this message will become **ICE PROTECT ALL ON**.

STAB Button

The STAB button controls the electromechanical de-ice system of the horizontal stabilizer. The button and associated states are modeled, but the button has no effect in the sim.

- OFF (Cyan): Electromechanical stabilizer de-ice will not be applied.
- ON (White): Electromechanical stabilizer de-ice is applied. This will trigger a white **A/I STAB ON** message. If all four top anti-ice buttons are ON, this message will become **ICE PROTECT ALL ON**.

PITOT/STATIC Button

The PITOT/STATIC button controls the pitot/static anti-ice heating mode. This momentary button has two states:

- NORM (Cyan): The pitot/static heat is applied automatically. Heat will begin to be applied during the takeoff roll when there is sufficient speed for cooling the hot element via airflow, or anytime while the aircraft is in the air. Heat will also be applied during an in-air engine failure.
- ON (Amber): The pitot/static heat is ON. This will trigger a yellow **P/S BUTTON ON** message while on the ground, to alert the pilots to limit time of use while on the ground. While in the air, this message will be white.

Ice Protection Indications

EIS Icing Indication

The ice detection indication is location under the landing gear indications and above the temperature indications on the EIS.

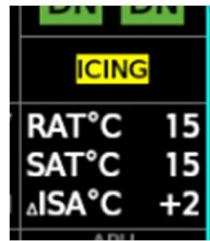


Fig 12-5-1 – EIS Icing indication

When icing is detected by the ice detectors and all four top anti-ice buttons are not set to ON, the ICING message appears in amber reverse video on the EIS. If all four top anti-ice buttons are set to ON, this indication turns to normal white text, which will be displayed until icing conditions are no longer sensed by the ice detectors.

Anti-Ice Synoptic

The Anti-Ice synoptic pane displays a number of ice protection values and can be accessed via the Systems page on a MFD GTC.



Fig 12-5-2 – Anti Ice Synoptic

The Anti-Ice synoptic pane displays the status of the windshield heating system, which when active, will appear on the windshield figures at the top of the synoptic. Temperatures will also appear in this area.

Wing leading edge temperature sensor readings appear at 4 positions along the wing leading edge figures, and behind those are the wing bleed air PSI readings and the wing bleed air inlet temperature. Underneath that appears the wing cross flow valve, and then the two wing anti-ice valves.

In the middle on the bottom horizontal main manifold line appear the engine bleed air valves, with the bleed isolate valve in the middle. Outboard and to the bottom of those are the HP engine bleed air valves.

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Hydraulic System Description

The Longitude is equipped with dual hydraulic systems powered by engine-driven hydraulic pumps pressurized to 3,000 PSI per side. System A receives hydraulic power from the left engine, and System B receives hydraulic power from the right engine. The hydraulic systems power a number of equipment items, including the rudder, brakes, spoilers, and more.

The hydraulic system also contains a Power Transfer and Conversion Unit that allows for hydraulic power to transfer from one system to another, if a hydraulic pump should fail. The PTCU also can be operated in a generator mode to convert hydraulic power to electrical power.

Simulation Notes

The Longitude includes a complete, custom hydraulic system that is fully flow based, using real world hydraulic formulae to manage system pressures based on pump output, individual accumulator fill percentages and pressure outputs, and connected system availability. It also contains a full temperature simulation of the hydraulic fluid mass based on pump work and other parameters.

All modes of the PTCU are modeled, including the full set of automation and logic that appears in the real aircraft. Additionally, the rudder standby system is modeled as well.

Hydraulic Fluid Reservoirs

Each hydraulic fluid reservoir is used to store hydraulic fluid for operation. Once the system is in operation, the reservoir utilizes a system pressure of 3,000 PSI. Fluid is also drawn from the reservoir into the hydraulic accumulators.

Engine Driven Pumps

An engine-driven pump provides pressure to the hydraulic system and modulates output to maintain a constant operating pressure of 3,000 PSI. The system may also be operated in a low pressure mode which actuates a depressurization valve for decreased pressure output.

Hydraulic Shutoff Valves

The hydraulic shutoff valves remove the engine driven pumps from the circuit. These valves are controlled with the respective HYDRAULICS PUMP A or B set to SHUTOFF.

Hydraulic System Accumulators

Hydraulic system accumulators are installed throughout the hydraulic systems to absorb transient demand spikes of the connected hydraulically powered components. Accumulators for nosewheel steering, ground spoilers, and brakes are installed in the systems. Additionally, the accumulators can provide a backup hydraulic charge to connected components in the case of a hydraulic pressure loss, until the accumulators are depleted.

Power Transfer and Conversion Unit (PTCU)

The PTCU is a versatile part of the redundant systems of the Longitude. Using a motor-generator and hydraulic transfer system, the PTCU can operate as a means of transferring power from one system to another, can use electrical power to act as a backup pump for a system, or can use hydraulic power to act as a backup generator for the electrical system.

In normal operations, when in power transfer mode, the unit will automatically use power from one system to ensure that the opposite system is also fully powered and pressurized.

Rudder Standby System (RSS)

The Longitude rudder standby system is a self contained hydraulic system that includes an electrically powered hydraulic pump and hydraulic fluid reservoir. The RSS can act as the source of actuating power for the rudder should there be a complete loss of hydraulic power in System A.

Hydraulic System Controls

The hydraulics system controls are located on the center pedestal, to the right of the throttle quadrant in the forward section of the panel.



Fig 13-3-1 Hydraulics system controls

HYDRAULICS PUMP Switches

The HYDRAULICS PUMP switches control the state of the engine-driven hydraulic pumps. These switches have the following three positions:

- NORM: The hydraulic pumps will follow normal operation. Pumps will be active when the engine is running.
- MIN – Powers the pump depressurization valve to lower the hydraulic system pump output pressure. The aircraft may experience reduced performance of hydraulic powered equipment on the connected hydraulic system. Depending on conditions and PTCU operation, this may trigger a yellow **HYD PRESS LOW A/B** message.
- SHUTOFF – The hydraulic pump will be shut off and the firewall shutoff valve will be closed. Hydraulically actuated equipment connected to the system may not operate. Equipment with connected hydraulic accumulators will function until the accumulators are depleted. This position will trigger a **HYD SHUTOFF A/B** message. This message will turn yellow if the pump is available, but the switch is still set to this position.

PTCU Knob

The PTCU knob controls the running mode of the Power Transfer and Conversion Unit. This knob has the following 5 positions:

- OFF: The PTCU will be disabled. No hydraulic transfer, emergency aux pump operation, or hydraulic motor-generator operation will be provided. This position will trigger a white **PTCU OFF** message.
- AUX A: The PTCU will use electrical power to provide emergency hydraulic pumping to System A. If System A already has sufficient pressure, the PTCU will revert to power transfer mode. This position will trigger a white **HYD AUX PUMP ON A/B** message.
- NORM: The PTCU will operate automatically. While in the NORM position, the PTCU will provide hydraulic power to the brake system to charge the parking brake accumulators upon aircraft power up (first System B, then System A), in order to ensure sufficient parking brake operation. The PTCU will also provide pump priming to System A or System B during their respective on-side engine starts. If neither of these operations are required, the PTCU will revert to power transfer mode. If the PTCU is not selected to the NORM position while on the ground during engine run or start operations, a yellow **PTCU NOT NORM** message will be triggered.
- AUX B: The PTCU will use electrical power to provide emergency hydraulic pumping to System B. If System B already has sufficient pressure, the PTCU will revert to power transfer mode. This position will trigger a white **HYD AUX PUMP ON A/B** message.
- HYD GEN: The PTCU will operate as a hydromechanical electrical generator. This will normally source from System B, but may be switched to sourcing from System A if the switch is moved away from HYD GEN for 1 second, then returned to the HYD GEN position. This position will trigger a white **HYD GEN ON** message. This message will turn yellow if the switch is in this position and there still is a different available primary power source.

RUDDER STANDBY Button

The RUDDER STANDBY button controls the operating state of the rudder standby system. This momentary button has the following modes:

- NORM (Cyan): The rudder standby system will engage upon loss of hydraulic pressure to System A.
- OFF (Amber): The rudder standby system will be powered off. If System A is currently without hydraulic pressure, this can cause the rudder to be inoperative. A yellow **RUDDER STANDBY OFF** message will be triggered.

Hydraulic System Indications

Hydraulics Synoptic Pane

The primary source of information relating to the hydraulics systems is on the Hydraulics synoptic pane, accessible via the System page on a MFD GTC.

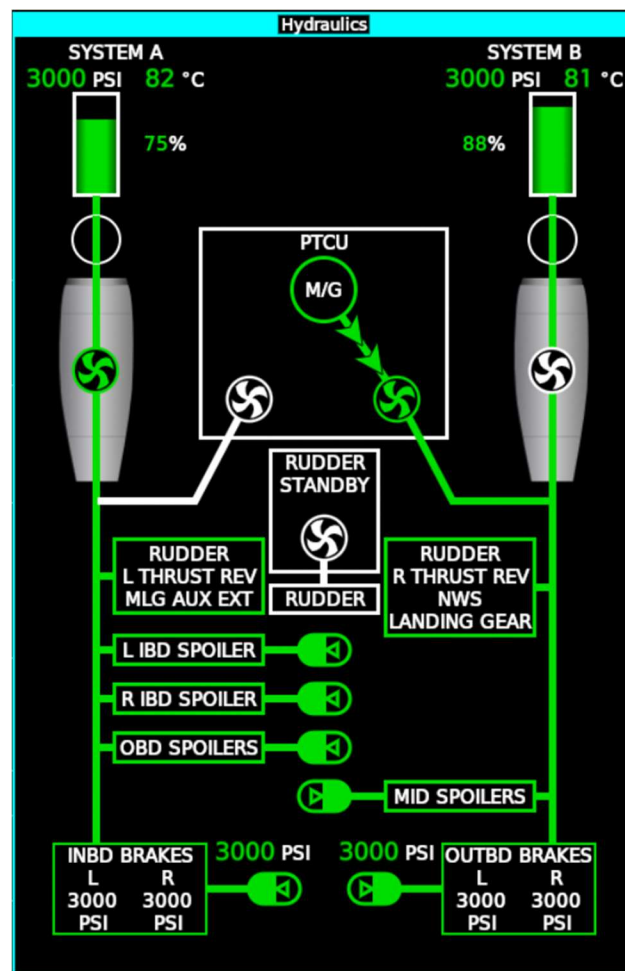


Fig 13-5-1 – Hydraulics synoptic pane

The Hydraulics synoptic pane displays numerous pieces of data about the hydraulics systems. The the top of each system side is the hydraulic system reservoir level, represented by a bargraph indicator with the percentage full value to the inboard side of the indicator. Above the reservoir indicator is the current system pressure and temperature. Normal values will be displayed in green and abnormal values in amber reverse video.

The firewall valve and engine-driven pump are also shown (active/connected in green, otherwise white). A main line extends downward to a number of connected systems, with labels for those systems. For those systems that have backup hydraulic accumulators, icons are shown also connected towards the center of the synoptic. Accumulators with sufficient stored pressure will be in green, otherwise in white.

At the bottom of the synoptic pane are the brake status boxes. These show the pressure measured at the hydraulic accumulator outputs in large text, above the accumulator icons. Inside the boxes are the labels for the connected brake systems and the currently applied braking pressure.

In the center of the synoptic is the rudder standby system box. The pump icon and rudder box will appear green when the standby system is active.

Above the rudder standby system is the PTCU indicator. This indicator shows a number of PTCU operational state:

- Dashed line from left to right pump: The PTCU is in hydraulic power transfer mode, but the systems are balanced. This is the normal operating condition in most circumstances.
- Arrow line from left to right pump: The PTCU is in hydraulic power transfer mode and the system is transferring power from System A to System B.
- Arrow line from right to left pump: The PTCU is in hydraulic power transfer mode and the system is transferring power from System B to System A.
- Arrow line from M/G to left pump: The PTCU is in Aux A mode and operating as a pump for System A using electrical power.
- Arrow line from M/G to right pump: The PTCU is in Aux B mode and operating as a pump for System B using electrical power.
- Arrow line from left pump to M/G: The PTCU is in Hyd Gen A mode and using hydraulic power from System A to run the electrical motor-generator to produce electrical power.
- Arrow line from right pump to M/G: The PTCU is in Hyd Gen B mode and using hydraulic power from System B to run the electrical motor-generator to produce electrical power.

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XIV – Landing Gear and Brakes

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Landing Gear and Brakes Description

The Longitude is equipped with trailing-link retractable main landing gear with a retractable cantilever nose landing gear. The landing gear system is electrically signaled but hydraulically actuated, and stored within the nose wheel well and the MLG wing box wheel wells.

The main landing gear contain a hydraulically actuated brake-by-wire system with anti-skid brakes and each wheel has independent inboard and outboard systems connected to opposite hydraulic systems. The emergency/parking brake applies equal power to all four brake assemblies. When hydraulic power is unavailable, the emergency/parking brakes can operate solely from the brake hydraulic accumulators for a number of cycles to ensure stopping power for landing in emergency situations.

Simulation Notes

The Longitude uses the sim brake system, but adds a number of effects on top. These effects include loss of main braking ability without hydraulic power, accumulator connection and depletion when using the parking brakes, and more. Anti-skid is simulated as well as a full brake temperature simulation taking into account wheel speed, brake pressure, and exposure to moving cool air while in motion.

Additionally, some smaller details such as wheel spin inhibit on landing gear retraction are also modeled.

Brake System and Assemblies

The main landing gear contain both inboard and outboard brakes, with the inboard brakes connected to hydraulic System A and the outboard brakes to hydraulic System B. This allows for full braking authority even with a single hydraulic system failure. The brake assemblies also contain the brake pressure and temperature sensors.

The system reads the pilot pedal position value and electronically modulates the brakes based on the pedal position and wheel speed. Brake pressure will be scaled while wheel speeds are high to prevent skid and slippage.

When the landing gear are retracted, the system will automatically apply brake pressure to spin down the wheels prior to them entering the landing gear bays. Pilot "tapping" of the brakes upon liftoff is not required. Upon leaving the ground, pilot control of the brakes is disabled.

Emergency/Parking Brake

The emergency/parking brake system are not on separate assemblies but engage the same brake assemblies equally with maximum brake pressure via independent dedicated hydraulic lines. In addition, the main braking system hydraulic check valve will engage in the event of hydraulic pressure loss, so that the brake hydraulic accumulators remain charged. Normal pedal braking action will be unavailable; however, engaging the emergency/parking brake system will use the charged accumulator power to operate the brake assemblies until the accumulators are depleted.



Fig 14-3-1 – Emergency/Parking brake handle

Engaging the parking brake while on the ground will trigger the white **PARK BRAKE ON** message. This message will turn red if the throttles are advanced beyond idle and will also trigger the red **NO TAKEOFF** message.

Nosewheel Steering

The nosewheel steering system provides 7 degrees of steering angle with the rudder pedals and 81 degrees of steering angle from the tiller. However, this is simulated for convenience in MSFS as having the full steering authority at low speeds from the rudder pedals, transitioning to 7 degrees during the beginning of the takeoff roll. The tiller wheel in the cockpit is modeled physically but is INOP.

Landing Gear

The landing gear are typical retractable tricycle style landing gear arrangement with a single up/down control lever. The emergency landing gear extension panel and system are not modeled. Due to this, we do still allow landing gear extension with no hydraulic pressure, so you cannot enter a state where the landing gear would be unable to extend in a situation where the real aircraft would be able to extend.

The landing gear handle is located on the inboard side of the copilot panel, underneath the PFD.



Fig 14-4-1 – Landing gear handle

A red **LANDING GEAR** message with accompanying “*Landing Gear, Landing Gear*” aural alert will be triggered under the following conditions:

- Gear are not down and locked and flaps are selected beyond flaps 2.
- Gear are not down and locked, radio altimeter is less than 500 feet AGL, and throttle is near flight idle.

Landing Gear and Brake Indications

EIS Landing Gear Indications

The landing gear position indicator is located on the left side of the EIS, underneath the flaps and spoiler indicator.



Fig 14-4-2 Landing gear indications

When the gear are up, white UP boxes appear in the respective indicator area. During gear transition, white crosshatch boxes are displayed. Once the gear are down, green DN boxes appear.

Hydraulics Synoptic Brake Indications

The currently applied brake pressure and available accumulator pressure are displayed for the brake assemblies on the Hydraulics synoptic pane.



Fig 14-5-1 – Hydraulics synoptic brake indications

Summary Synoptic Brake Indications

Each individual brake assembly brake application pressure and sensor temperature are shown on the Summary synoptic pane. Abnormal values are displayed in amber reverse video.

BRAKES				
	L OUTBD	L INBD	R INBD	R OUTBD
PRESSURE	500 PSI	500 PSI	600 PSI	600 PSI
TEMP	181 °C	181 °C	179 °C	181 °C

Fig 14-5-2 - Summary synoptic pane brake indications.

Flight Control Synoptic Brake Indications

Each individual brake assembly brake application pressure and sensor temperature are shown on the Flight Control synoptic pane. Abnormal values are displayed in amber reverse video, and the brake temperature bargraph bug will also turn amber if the value exceeds the green range.

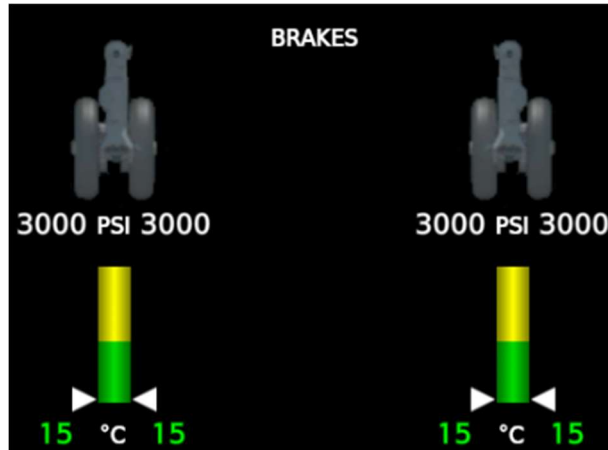


Fig 14-5-3 – Flight Control synoptic pane brake indications

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Flight Control System Description

The Longitude flight control system is designed for a comfortable and precise piloting experience with excellent handling characteristics throughout the flight envelope. Pitch control is conventional mechanical control, with roll control also a conventional mechanical control, but augmented by a hydraulically powered roll spoiler system.

The spoiler system is also used to provide speed brake functions in the air as well as ground spoiler functions on the ground. Flaps are electronically actuated. The rudder is a “fly-by-wire” system providing things like automatic yaw-damping and control scaling.

Simulation Notes

The Longitude uses primarily the standard MSFS control system but does add a few interactions with other systems as well. Automatic YD logic is implemented, as well as the failure of the rudder and YD with no hydraulic power and RSS off. Roll spoilers are also simulated, with a reduction in roll authority when the roll spoilers cannot be used due to hydraulic shutdown. Finally, the speedbrake and fully automated ground spoiler system are also faithfully simulated.

Control lock and disconnects are not modeled.

Pitch Controls

Elevator

The elevator is controlled via direct mechanical linkage to the cockpit control columns. Moving the control columns fore or aft will change the angle of the elevator.

Pitch Trim

Horizontal stabilizer trim is normally operated on the Longitude in MSFS. Dual channel and secondary trim functions are not presently modeled. Stabilizer trim is displayed on the EIS, with a green band while on the ground to indicate the takeoff range. The takeoff range band accommodates all valid CGs and does not move based on CG. Please see Normal Procedures, Cockpit Preparation for the appropriate trim setting for the aircraft CG.

The pitch trim must be in the green range for takeoff. Values outside the green range will produce a **NO TAKEOFF** message (white, then red if throttles are advanced near TO).



Fig 15-2-1 – EIS horizontal stabilizer trim indications

Roll Controls

Ailerons

The ailerons are controlled via direct mechanical linkage to the cockpit control wheel. Turning the control wheel left or right will change the angle of the ailerons.

Roll Spoilers

The four outboard spoiler panels (two on each wing) act as roll spoilers and operate together with the ailerons for roll control. These panels are hydraulically actuated. If hydraulic power to the spoilers is not available, the plane will experience reduced roll authority. When hydraulic power is lost, check valves close to maintain accumulator charge for the ground spoiler system and roll spoilers will not be available.

Aileron Trim

Aileron trim is normally operated on the Longitude in MSFS. Aileron trim must be within the green range for takeoff. Values outside the green range will produce a **NO TAKEOFF** message (white, then red if throttles are advanced near TO).



Fig 15-3-1 – EIS aileron trim indications

Yaw Controls

Rudder

The rudder is a fly-by-wire unit controlled via signaling of the rudder pedal position to the rudder control unit. The rudder is hydraulically actuated by the control unit.

Integrated into the rudder system is automatic yaw dampening. Yaw dampening will be automatically engaged by the system during the correct phases of flight. No YD indication will appear in the AFCS Status Box at the top of the PFD, and there is no YD button on the AFCS control panel.

Loss of hydraulic power to System A will cause the Rudder Standby System to engage, providing backup pump power to the rudder. If the RSS is also unavailable, the rudder will be inoperative (including yaw dampening). In this case the yellow **RUDDER FAIL A-B** and **YAW DAMPER FAIL A/B** messages will be triggered.

Rudder Trim

Rudder trim is normally operated on the Longitude in MSFS. Rudder trim must be within the green range for takeoff. Values outside the green range will produce a **NO TAKEOFF** message (white, then red if throttles are advanced near TO).



Fig 15-4-1 – EIS rudder trim indications

Speedbrakes and Ground Spoilers

Speedbrakes

The speedbrakes share the same four inboard spoiler panels as the roll spoilers, and are controlled by the SPEEDBRAKE handle, which is located to the left of the throttle quadrant. The speedbrake is limited to 35 degrees of spoiler direction in flight, or 17.5 degrees if the flaps are beyond the flaps 2 position.



Fig 15-4-2 – Speedbrake handle

The speedbrakes can be deployed progressively by moving the speedbrake handle down to achieve the desired amount of braking. Speedbrakes can be deployed at any speed but must be retracted by 500 feet AGL on the landing profile. Failure to retract the speedbrakes by this altitude will trigger the yellow **SPEEDBRAKES** message.

A speedbrake auto-stow function automatically retracts the speedbrakes when throttle exceeds 30 degrees throttle level angle (around CRU power) or when the AOA of the aircraft is sufficient to trigger the stick shakers. If the speedbrakes are auto-stowed, a yellow **SPEEDBRAKE AUTO STOW** message will be triggered.

Resetting the speedbrake handle fully upward (retracted) will reset the speedbrake auto-stow logic.

Ground Spoilers

The ground spoiler system includes all six spoiler panels and is a fully automatic system that does not require any pilot action. Ground spoilers deploy automatically when wheel speed is greater than 35 knots

and both throttle levers are at approximately idle. The ground spoilers automatically retract below 30 knots, or when the throttles are advanced away from idle. In addition to aiding in slowing the plane, the ground spoilers also reduce lift, increasing the weight on the nose landing gear for optimal steering and braking effectiveness. Ground spoilers extend the spoiler panels 60 degrees.

In the event of a loss of hydraulic power, the ground spoiler hydraulic accumulators will retain enough charge to power the ground spoilers upon landing or during a rejected takeoff. When the accumulators are depleted, ground spoilers will no longer function.

Flaps

Flaps are operated via the flaps handle on the right side of the center pedestal. The flaps have four detent settings:

- UP (0 degrees)
- 1 (7 degrees) – limited to 250 KIAS
- 2 (15 degrees) - limited to 230 KIAS
- FULL (35 degrees) - limited to 180 KIAS

Flight Control System Indications

EIS Flaps and Spoiler Indications

The EIS Flaps and spoiler indications are located below the fuel quantity and temperature indicators. The indicator shows the currently selected flaps position (cyan bug), the current flaps position (right needle) and the current spoiler angle. The spoiler position indicator does not indicate roll spoiler action, but only speedbrake and ground spoiler action.



Fig 15-5-1 – EIS flaps and spoiler indications

Flight Controls Synoptic

The aircraft diagram at the top of the Flight Controls synoptic shows the present position of all of the aircraft control surfaces, including the elevator, ailerons, rudder, spoilers, and flaps. Current positions are indicated by green bars that move up and down or side to side.

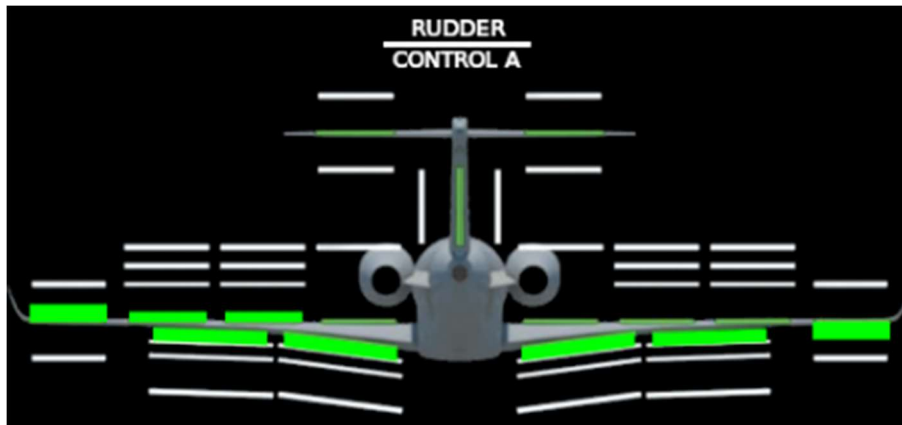


Fig 15-6-1 – Flight control synoptic controls diagram

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XVI - Lighting

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Lighting Description

The Longitude is equipped with a number of interior and exterior lights. Exterior lights consist of multiple fixtures designed for day and night operations and to assist in visibility & maintenance of the aircraft. Interior lighting is also provided and consists of direct and indirect lighting for operational visibility inside the flight deck in all lighting conditions.

Simulation Notes

The Longitude simulates a comprehensive suite of external and cockpit lighting elements. Cabin lighting is not specifically modeled. Automatic logic for a number of exterior lights is also fully simulated.

Cockpit Lighting

Overhead Lighting Controls



Fig 16-2-1 – Overhead cockpit lighting controls

The overhead lighting panel contains the following cockpit lighting controls:

- PANEL Knob: Controls the brightness of the instrument panel label backlighting. The Day position is full intensity.
- FLOOD Knob: Controls the brightness of the overhead cockpit flood light.
- AUX Knob: Not modeled

Glass Cockpit Panel Lighting

Brightness of the PFDs, MFD, and GTCs are controlled by 3 dual-concentric knobs. The PFD/GTC knobs are located on the outboard side of the pilot and copilot lower panel below the PFD, and the MFD/GTC knob is located in the forward left of the center pedestal.



Fig 16-2-2 – Glass Cockpit Panel lighting knobs

Cockpit Map Lights

Map light brightness is controlled by the left and right MAP LIGHT knobs, located under the PFD/GTC panel display brightness knobs on the outboard side of the pilot and copilot lower panel.



Fig 16-3-1 – Cockpit map light knob

Exterior Lighting



Fig 16-3-2 – Overhead lighting panel

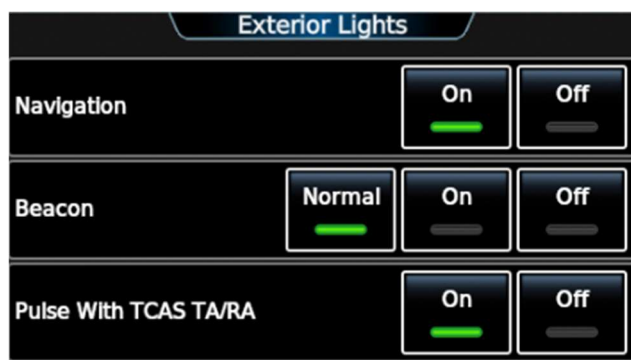


Fig 16-3-3 – Exterior Light GTC Page

Navigation Lights

LED navigation lights are located on the left and right winglets and at the trailing edge of the tail bullet fairing. These lights are colored red (left wingtip), green (right wingtip) or white (tail). Navigation lights are automatically selected on when the Garmin G5000 is powered up. Control of the navigations lights on or off is performed via the GTC Exterior Lights page, accessed via the Systems page.

Beacon and Anti-Collision Lights

The beacon and anti-collision lights are dual use fixtures located at the top of the tail bullet fairing and the belly of the aircraft, as well as one anti-collision only at the trailing edge of the bullet fairing. The

beacon function of the lights is a flashing red light, while the anti-collision function flashes the lights white.

The beacon function is controlled on the Exterior Lights GTC Page. The default power on is the Normal mode, which will turn on the beacon lights anytime an engine is set to RUN or the starter is engaged. Setting the beacon lights to On will turn them on, and Off will turn them off.

The white flashing anti-collision function is selected ON by pressing the ANTI COLL button on the overhead lighting panel.

Landing, Recognition, and Pulse Lights

A pair of high intensity lights are installed in the belly of the Longitude and provide wide beam lighting for low light landing operations. Additionally, these lights also serve as the recognition lights (constant, low intensity) or pulse lights (flashing, high intensity).

Landing lights are selected with the L LDG and R LDG buttons on the overhead lighting panel. Recognition lights are selected with the RECOG button on the overhead lighting panel, and pulse lights with the PULSE button. The recognition or pulse lights functions cannot be selected when the landing lights function is also selected.

Automatic pulse light activation is configurable on the GTC Exterior Lights page. The On setting will cause pulse lights to flash when TCAS issues a TA or RA. Off will deactivate the automatic logic.

Taxi Lighting

Taxi lighting is installed in the nosewheel and is a high intensity element designed for increased environment visibility during taxi operations. Additionally, wingtip downwash lights activate to help pilots and ground crew identify the wingtip location during night and low-light operations.

Taxi lights are selected with the TAXI button on the overhead lighting panel.

Wing Inspection Lights

Two lights installed in the fuselage provide light to the wing leading edges to aid the pilots in identifying ice accumulation in low light conditions. These lights are selected with the WING INSP button on the overhead lighting panel.

Tail Flood Lights

The tail flood lights, also known as the logo lights, illuminate the tail logo and identifier area for plane identification at night. These lights are selected with the TAIL FLOOD button on the overhead lighting panel.

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XVII - Normal Procedures

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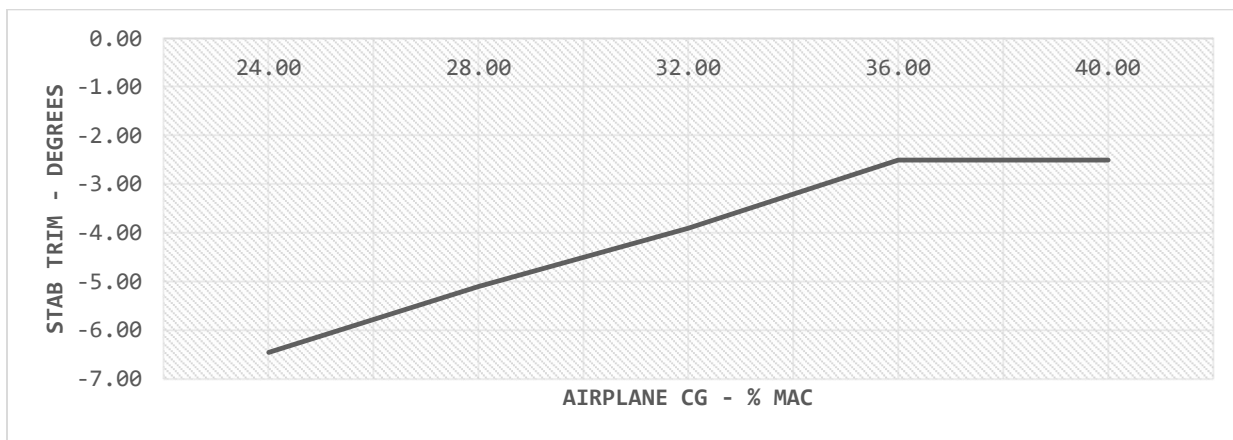
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Cockpit Inspection

1. STBY PWR Switch **TEST and Hold (Green light for min 10 sec)/ON**
2. EMER LTS Switch **ARM**
3. LANDING GEAR Handle..... **DOWN**
4. BATT Buttons (Both)..... **ON, Check Volts**
5. EIS/CAS..... **Check**
6. External Power Source..... **As Desired**
 - a. EXT PWR Button (if AVAIL illuminated) **ON**
 - b. BATT Amps (both) **0 or Charging**
---AND/OR---
 - c. APU Knob..... **ON/START**
 - d. External Power **Disconnected**
 - e. BATT Amps (both) **0 or Charging**
7. Exterior/Interior Lights **ON/Check/Off, or as Required**

Cockpit Preparation

1. Cockpit Inspection **Complete**
2. EIS/CAS **Check**
3. APU Knob (if not already started) **ON/START**
4. External Power (if used) **Disconnected**
5. Engine Dry Motor **Consider**
6. ATIS/Clearance **As Required**
7. Trims **Check/Set for Takeoff**



8. Weight and Fuel (MFD GTC: Perf) **Completed**
9. Takeoff Data (MFD GTC: Perf) **Completed**
10. V Speeds **Verify/Set**
11. Pressurization LDG ELEV **Verify/Set**
12. Fuel Quantity and Balance **Check**
13. Autopilot (First Flight of Day) **Engage/Disengage**

Before Start

1. EMER/PARK BRAKE Handle **Set (PARK BRAKE ON Displayed)**
2. EIS/CAS **Check**

Starting Engines (Using APU)

1. Throttles **IDLE**
2. ENGINE RUN/STOP Button (either engine) **RUN**
3. START Pressure **Verify \geq 32 PSI**
4. ENGINE STARTER Button **Push**
5. Engine Instruments **Monitor**
6. Opposite Engine **Repeat Steps 1 thru 4**
7. EIS/CAS **Check**

Before Taxi

1. Flight Controls **Free and Correct/Check**
2. Speedbrakes **Check/Retracted**
3. Flaps **Set for Takeoff**
4. Flight Instruments/Avionics **Check**
 - a. Attitude & Heading, Air Data Displays **Aligned/No Flags**
 - b. Altimeters **Confirm and Compare** (75 feet of field elevation, 50 feet of each other)
5. ENGINE ICE PROTECTION Buttons **As Required**

Taxi

1. Exterior Lights **As Required**
2. EMER/PARK BRAKE Handle **Stowed**
3. Brakes **Check**
4. Nosewheel Steering **Check**
5. Thrust Reversers **Check, as Required/Stowed**
 - a. Deploy (Reverse Idle) **Verify Green T/R DEPLOY Indications**
 - b. Stow **Verify Indications Clear**

Before Takeoff

1. Flaps **Set for Takeoff**
2. Speedbrakes **Retracted**
3. Trims **Set for Takeoff**
4. Ice Protection Systems **Check, as Required**
5. V Speeds **Displayed**
6. SPD Knob **FMS**
7. Crew Briefing **Complete**
 - a. If Rolling Takeoff Planned, add 500 Feet to Computed Takeoff Distance
8. Radar **As Required**
9. PITOT/STATIC Button (in icing conditions, within 1 min before takeoff) ... **ON 15 Seconds then NORM**

-----**CLEARED FOR TAKEOFF**-----

1. Flight Controls **Free**
2. ICE PROTECTION Buttons **As Required**
3. Exterior Lights **As Required**
4. EIS/CAS **Check**

Takeoff

Static Takeoff

1. Throttles..... **TO**
2. Autothrottle (if used) **Check Green HOLD**
3. EIS/CAS..... **Check** (N1 matches command, green TO)
4. Brakes..... **Release**
5. Elevator Control **Rotate at V_R** (10 degrees initial pitch)

Rolling Takeoff

1. Brakes..... **Release**
2. Throttles..... **TO** (within 500 feet after brake release)
3. Autothrottle (if used) **Check Green HOLD**
4. EIS/CAS..... **Check** (N1 matches command, green TO)
5. Elevator Control **Rotate at V_R** (10 degrees initial pitch)

After Takeoff/Climb

1. Landing Gear (at positive rate of climb)..... **Up**
2. Flaps (at or above $V_2 + 20$ knots) **Up**
3. Throttles..... **CLB**
4. ICE PROTECTIONS Buttons..... **As Required**
5. Pressurization **Check**
6. Altimeters (at transition altitude)..... **Set**
7. Exterior Lights..... **As Required**
8. APU Knob (prior to climb above FL350) **OFF**

Cruise

1. Throttles..... **CRU or as Desired**
2. Autopilot (if in RVSM airspace)..... **As Required**
3. Altimeters (if in RVSM airspace)..... **Crosscheck** (within 200 feet at 1 hour intervals or less)

Descent

1. Pressurization LDG ELEV..... **Verify Landing Elevation**
2. APU Knob (at or below FL310)..... **ON/START, as Desired**
3. Altimeters (at transition level)..... **Set**
4. Exterior Lights..... **As Required**

Approach

1. Landing Data..... **Confirm**
 - a. V Speeds..... **Set**
 - b. Landing Distance **Calculate**
2. ICE PROTECTION Buttons..... **As Required**
3. Flight Instruments/Avionics
 - a. FMS/Navigation Aids..... **Set, as Required**
 - b. Minimums..... **Set**
 - c. Altimeters..... **Verify Setting**
4. Crew Briefing..... **Complete**
5. Flaps **1 or 2, when Desired**

Before Landing

1. Landing Gear **Down** (3 Green)
2. Flaps **Full**
3. Exterior Lights **As Required**
4. Speedbrakes **Retracted**
5. EIS/CAS **Check**
6. Autopilot (prior to minimum use height) **Disengage**
7. Airspeed (minimum) **V_{REF}**

Landing

1. Autothrottle (if used) **Check Green RETARD at 50 feet AGL**
2. Throttles **IDLE**
3. Brakes (after nosewheel touchdown) **Apply**
4. Thrust Reversers **Deploy** (Reverse Idle by 45 KIAS)

Go-Around

1. TO/GA Button (either throttle) **Push**
2. Throttles **TO**
3. Pitch Attitude **7.5 Degrees Nose Up Initially**
4. Flaps **2**
5. Climb Airspeed **V_{APP} (Minimum)**
6. Landing Gear (at positive rate of climb) **Up**
7. Flaps (at or above V_{APP} + 10 knots) **Up**
8. SPD Knob **FMS**
9. Throttles **As Required**

After Landing

1. Thrust Reversers **Stow**
2. Flaps **As Desired**
3. ICE PROTECTION:
 - a. ENGINE Buttons (both) **As Required**
 - b. WING Button **OFF**
 - c. STAB Button **OFF**
4. Exterior Lights **As Required**

Shutdown

1. Throttles **IDLE**
2. EMER/PARK BRAKE Handle **Set**
3. ENGINE ICE PROTECTION Buttons (both) **OFF**
4. ENGINE RUN/STOP Buttons (both) **OFF**
5. EMER LTS Switch **OFF**
6. STBY PWR Switch **OFF**
7. APU Knob **OFF**
8. Exterior Lights **Off**
9. Batt Buttons (both) **OFF**

Quick Turn

1. Throttles..... **IDLE**
2. EMER/PARK BRAKE Handle..... **Set**
3. ENGINE ICE PROTECTION Buttons (both) **OFF**
4. ENGINE RUN/STOP Buttons (both)..... **STOP**
5. Exterior Lights **As Required**
6. Electrical Power Source..... **As Desired**
 - a. APU Knob (if not running)..... **ON/START**
 - b. BATT Amps (both) **0 or Charging**
---OR---
 - c. EXT PWR Button (if AVAIL illuminated) **ON**
 - d. BATT Amps (both) **0 or Charging**
7. Return to Normal Procedures, Cockpit Preparation

Starting APU

1. EIS/CAS **Check**
2. APU Knob **ON**
 - a. Green digits for APU RPM% and EGT C are displayed within 10 seconds of selecting ON
3. APU Knob (at or below FL310) **START**
4. APU RPM **Stabilizes 98%-100%**
5. APU BLEED Switch **NORM**
6. APU GEN Switch **ON**
7. Environmental Controls **As Desired**

Engine Dry Motor

Engine life can be reduced if ground starts are initiated between 15 and 180 minutes after engine shutdown. If engine restarts are desired within this time, it is recommended to perform an engine dry motor. After dry motor, the engine may be started after 3 minutes and before 40 minutes have elapsed.

NOTE:

Engine starter operation requires bleed air from the APU or opposite engine. If using opposite engine bleed air, engine should be at IDLE + 25% N1 during the dry motor procedure

1. Throttle (affected side) **IDLE**
2. ENGINE RUN/STOP Button (affected side) **STOP**
3. ENGINE STARTER Button (affected side) **Push and Hold**
4. ENGINE STARTER Button (affected side) **Release when N2 19% or 15s Elapsed Time**
5. Delay Before Next Start Attempt **When ENG DRY MTR PROC L/R CAS Message Clears**

Starting Engines (Using Cross-Bleed)

1. Throttles..... **IDLE**
2. ENGINE RUN/STOP Button (either engine) **RUN**
3. START Pressure **Verify \geq 32 PSI**
4. ENGINE STARTER Button **Push**
5. Engine Instruments..... **Monitor**
6. Opposite Engine **Start**
 - a. Throttle (non-running engine) **IDLE**
 - b. Throttle (running engine) **IDLE + 25% N1 Minimum**
 - c. ENGINE RUN/STOP Button (non-running engine) **RUN**
 - d. Repeat Steps 3 thru 5 (non-running engine).
 - e. Throttles..... **IDLE**
7. EIS/CAS..... **Check**