AUXILIARY POWER UNIT

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CHAPTER 5

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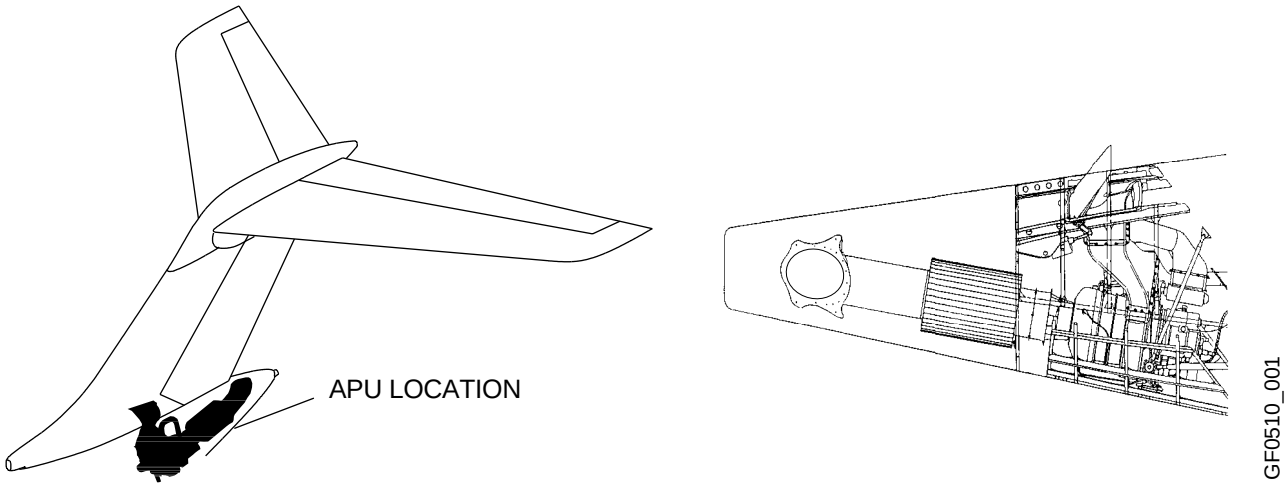
GENERAL

An Allied-Signal RE 220 gas turbine Auxiliary Power Unit (APU) is installed in a fire proof enclosure in the tail cone of the airplane (beneath the airplane rudder and elevator control systems) and has a fire detection element system (see Fire Protection System Chapter 9). The APU is installed outside of the main engine rotor burst zone which enhances airplane high altitude operation.



The APU provides bleed air for cabin cooling and heating through the Environmental Control System (ECS), Main Engine Starting (MES) and electrical power on the ground and in flight.

Under high demand load conditions, the APUs electrical loads take priority over pneumatic loads.

The main component of the electrical system is the Full Authority Digital Engine Control (FADEC). The APU FADEC interfaces with EICAS and the Central Aircraft Information Maintenance System (CAIMS), providing failure detection and isolation to faulty components.

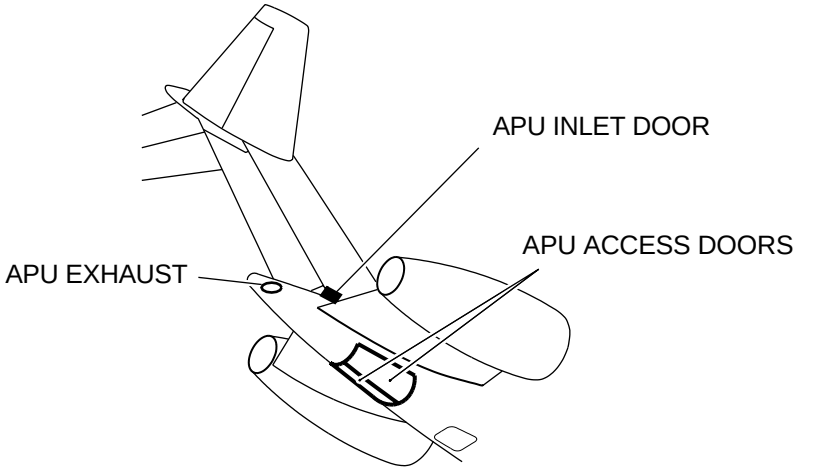
Control of APU speed is automatic and monitoring of APU Exhaust Gas Temperature (EGT), speed, fuel and oil pressure is through the FADEC. The FADEC also records operating hours and start cycles.

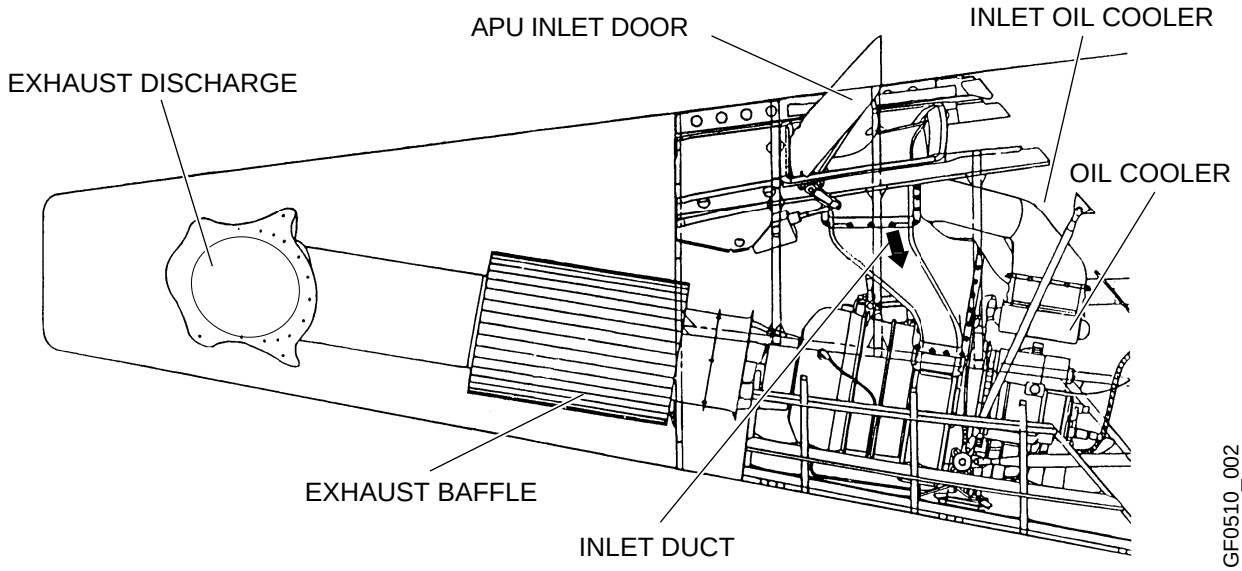
The engine speed for normal continuous steady state is displayed as 100% RPM and overspeed protection is provided. The APU has automatic protective shut down for abnormal ground and in flight conditions.

APU start and run is initiated by a single switch, located on the APU control panel in the flight compartment. Operation and control of the APU electric and bleed system is performed at the ELECTRICAL and BLEED/AIR CONDITIONING ANTI-ICE PANEL respectively.

For APU operating limitations refer to the Flight Crew Operating Manual (FCOM) CSP 700-6 VOL 1, Chapter 2 LIMITATIONS.

APU ACCESS AND COMPONENT LOCATION





APU Compartment

The APU is mounted in the tail cone by a multi-axis suspension rod system, securing it in all axes.

The APU compartment is completely sealed from the atmosphere with the exception of the inlet to the oil cooler system and the APU air inlet. The APU utilizes exhaust flow to pump cooling air through the oil cooler and to the APU and its associated components. The APU compartment is also isolated from the rest of the airplane for fire protection.

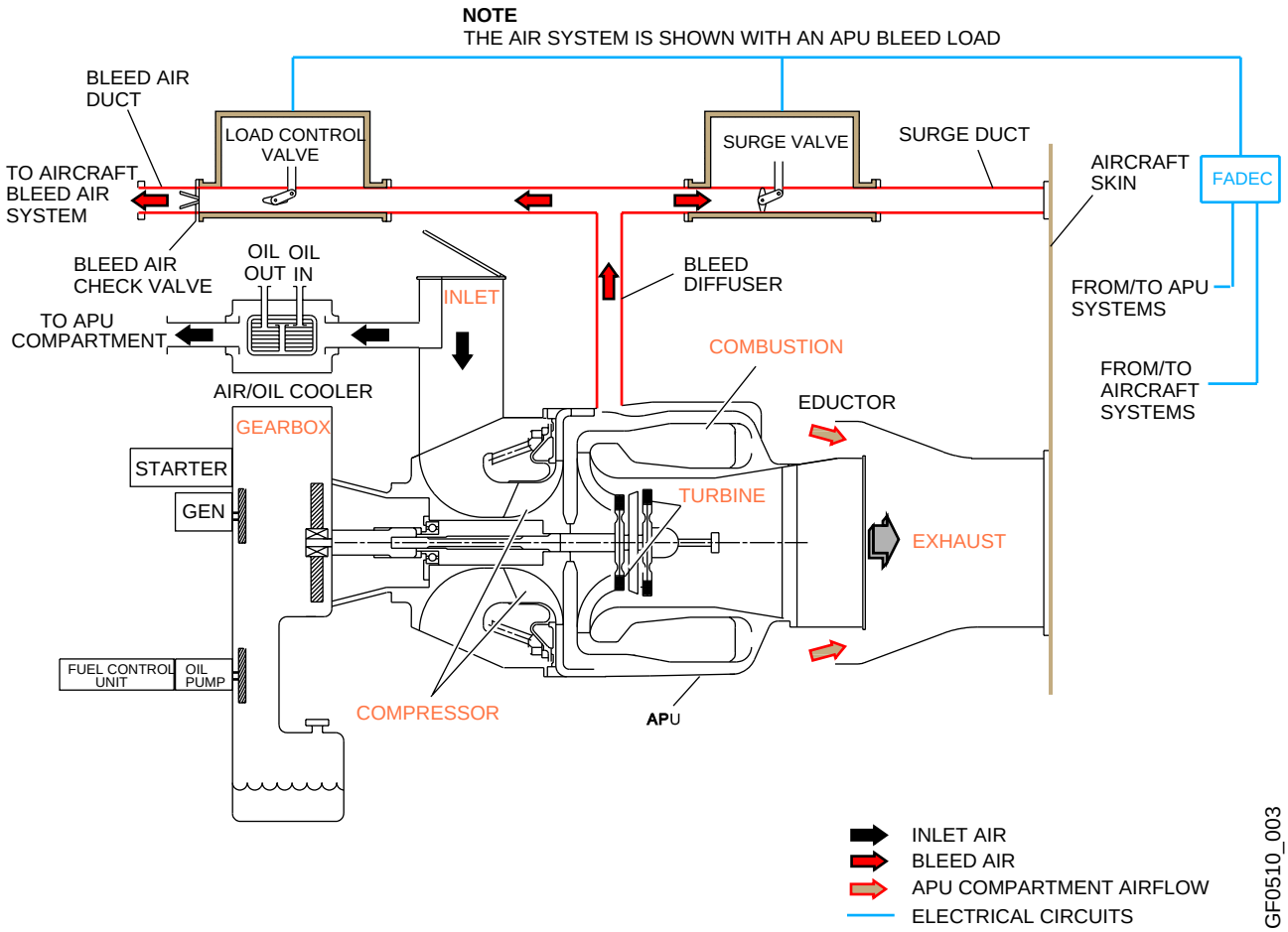
Cooling of the APU compartment is accomplished by an air to oil heat exchanger and by air flow over the APU through the enclosure (via the APU inlet). The airflow through the inlet splits in two sections. One section allows air to flow to the inlet plenum (to the compressor), while the other section allows the air to flow through the oil cooler to provide cooling for the APU oil. The air flowing through the oil cooler then passes through the compartment to cool the APU and its mounted components. This air is then exhausted overboard via the APU eductor.

APU GENERAL ARRANGEMENT

The APU consists of the following:

- Inlet Door − Variable position. The door schedules are sequenced as a function of weight-on-wheels, airplane MACH number and APU speed.
- Compressor − Is a single stage centrifugal impeller. Delivers approximately 52 psia bleed pressure at normal operating speed.
- Combustor − Contains 10 fuel nozzles and 2 igniters.
- Turbine − Two stage axial flow turbine which drives the compressor/gearbox.
- Gearbox − Provides the sump for the lubrication system and mounting of component and accessories.
- Exhaust − The flow across the APU and oil cooler is created by utilizing the exhaust discharge velocity.
- Monitor zones for fire/overheat/smoke events, FIDEEX system health and status.

APU SYSTEM SCHEMATIC



APU SYSTEM SCHEMATIC (CONT'D)

Lubrication

The lubrication system incorporates an integral oil reservoir. The two main areas that are lubricated are the gearbox and turbine bearings.

The gearbox sump is the reservoir and can be filled through the fill cap. The APU can also be serviced on ground only, using the airplane remote oil replenishment system, simplifying post flight maintenance actions.

The lubrication system consists of the following components:

- Oil filters − Lube and generator scavenge.
- Oil temperature sensor − Sends an input to the FADEC for both minimum oil temperature and high oil temperature protection. When oil temperature increases to a high predetermined value for 10 seconds, the APU (on ground only) will shut down.
- Low Oil Pressure (LOP) switch − When pressure drops below a predetermined PSIG after the APU has reached on-speed (not less than 99%) for 15 seconds, the APU (on ground only) will shut down automatically.
- Oil cooler − Will bypass oil at a predetermined lower than normal operating temperature and flow through the cooler when temperatures are above the normal operating range.
- Magnetic Chip Collector (visual inspection) − Provides visual indication of metal particles within the system.

Oil Pressure

On the prestart BITE check, the LOP switch is checked by the FADEC. During operation, if oil pressure decreases below a predetermined PSIG for approximately 15 seconds (on ground), automatic shut down will occur and an “APU OIL LO PRESS” caution message will come on.

A low oil pressure condition in flight will not cause an APU protective shut down.

Gravity Oil Fill

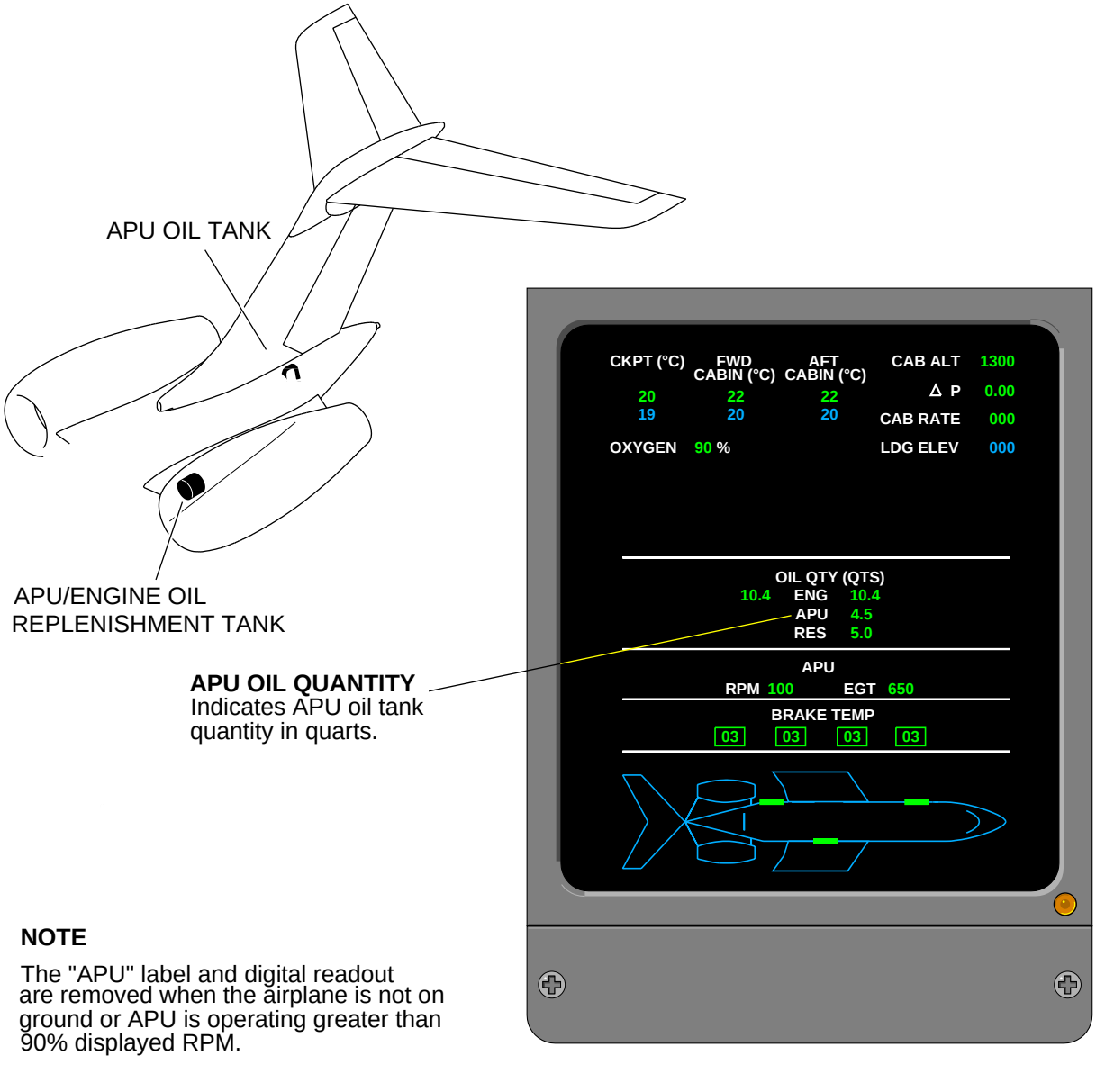
The APU oil sump can be filled through the gravity fill cap. The oil reservoir for the APU is an integral part of the accessory gearbox assembly and has a capacity of 5.25 quarts, with the add level at 3.75 quarts. The gravity fill is designed for a “fill to spill” ease of servicing and used only when the oil replenishment system does not function.

OIL REPLENISHMENT SYSTEM

The oil replenishment tank volume contains 5.7 liters (6 US quarts). APU oil level is measured via a sensor located in the APU oil tank which provides quantity information for the EICAS STAT page. Electrical failure of this sensor will be detected during the built-in-test and the quantity indicating value will change from a numerical value to amber dashes on EICAS. An “APU OIL LO QTY” advisory message will occur on EICAS (on ground only), when the APU oil level reaches approximately 3.5 US quarts and the APU has not been operating for 15 minutes.

OIL REPLENISHMENT SYSTEM (CONT'D)

An oil replenishment tank is located in the aft equipment bay and contains an electrical pump and sensor probe for quantity level. The oil replenishment (pressure filling) system is designed for ground use only and serves both main engines and APU. A three way electrical valve is incorporated in the replenishment system to allow transfer of oil to the system being topped up (either engine or APU).



NOTE

The "APU" label and digital readout are removed when the airplane is not on ground or APU is operating greater than 90% displayed RPM.

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The oil quantity digital readout will turn amber when the “APU OIL LO QTY” message is displayed.

OIL REPLENISHMENT SYSTEM (CONT'D)

Oil Replenishment System Filling

The system can be operated using the battery or external electrical power. Oil level monitoring is required during servicing to verify that the system stops automatically when the full level is reached.

NOTE

To protect against overfilling due to system component failures maintenance instructions must be followed according to the Airplane Maintenance Manual.

The oil filling system is operated through the oil replenishment panel located on bulkhead 280 (left side behind the pilot's seat) in the flight compartment.

NOTE

1. A reservoir TANK LO light remaining on three seconds following panel power-up indicates that the reservoir is low. Under this condition, re-filling is inhibited until the reservoir is filled.
2. If a low oil replenishment condition occurs during a fill, the system will shut down.

Oil is to be added to the APU when the "APU OIL LO QTY" advisory message is on EICAS and the LO OIL for APU display is shown on the oil replenishment panel.

The switch legends on the oil replenishment panel can only be displayed when the SYSTEM ON switch is selected.

The APU may be replenished if:

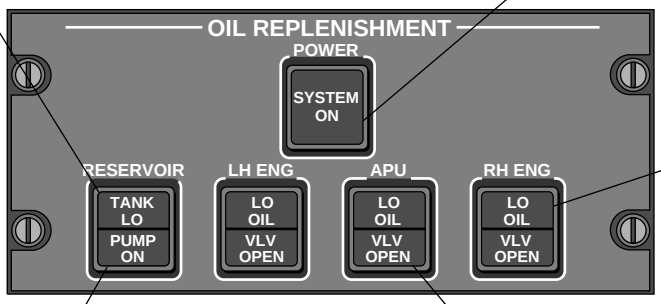
- The APU has been shut down for a minimum of 15 minutes.
- The APU is not already full.
- Both engines are not running and one of the other engines is not currently being replenished.

OIL REPLENISHMENT PANEL

TANK LO
The reservoir TANK LO legend comes on to indicate that the reservoir is low in quantity.

SYSTEM ON
Selecting the POWER switch does the following:

- The SYSTEM ON legend illuminates.
- A three second lamp test will be carried out on all annunciators.



LO OIL (APU)
The LO OIL legend comes on to indicate that the APU is low in oil quantity and will remain on until the APU oil tank is replenished.

PUMP ON
Selecting the PUMP ON switch does the following:

- The reservoir pump will operate and the PUMP ON legend will come on to indicate operation. The legend will remain on until the correct level of the system to be topped up is achieved.

VLV OPEN (APU)
Selecting the switch will illuminate the VLV OPEN switch legend indicating valve operation. Oil will be pumped from the reservoir (through the valve) to the engine until full is achieved.

- The VLV open and LO OIL switch legends will go out when the correct level is reached.

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Operation

The following procedural steps outlined are to be used only as a guide to replenish the APU oil system. The Airplane Maintenance Manual takes precedence over all servicing procedures.

- Confirm that the “LO OIL” lamp on the oil replenishment panel corresponds to the condition indicated on EICAS “APU OIL LO QTY” advisory message.
- Select the switch labeled “APU” on the oil replenishment panel.
- Confirm that the “PUMP ON” (below reservoir label) and “VLV OPEN” (below the APU label) legends are displayed on the oil replenishment panel.
- Select the “POWER” switch on the oil replenishment panel, “SYSTEM ON” legend on.
- Monitor the oil level on EICAS for both the APU and reservoir (example: if approximately 1 liter or 1 US quart is added to the APU, the oil replenishment tank level should have reduced by the same amount).
- When the APU reaches its designed level (between 4.5 and 5.5 qts.) confirm that the “PUMP ON” legend on the oil replenishment panel goes out (indicating pump stoppage). Also confirm that the “VLV OPEN” legend on the oil replenishment panel goes out (indicating valve closure).
- Select the “POWER” switch, “SYSTEM ON” legend extinguishes. Record the amount of oil added and a walk around for external leakage (oil overfill) should be carried out.

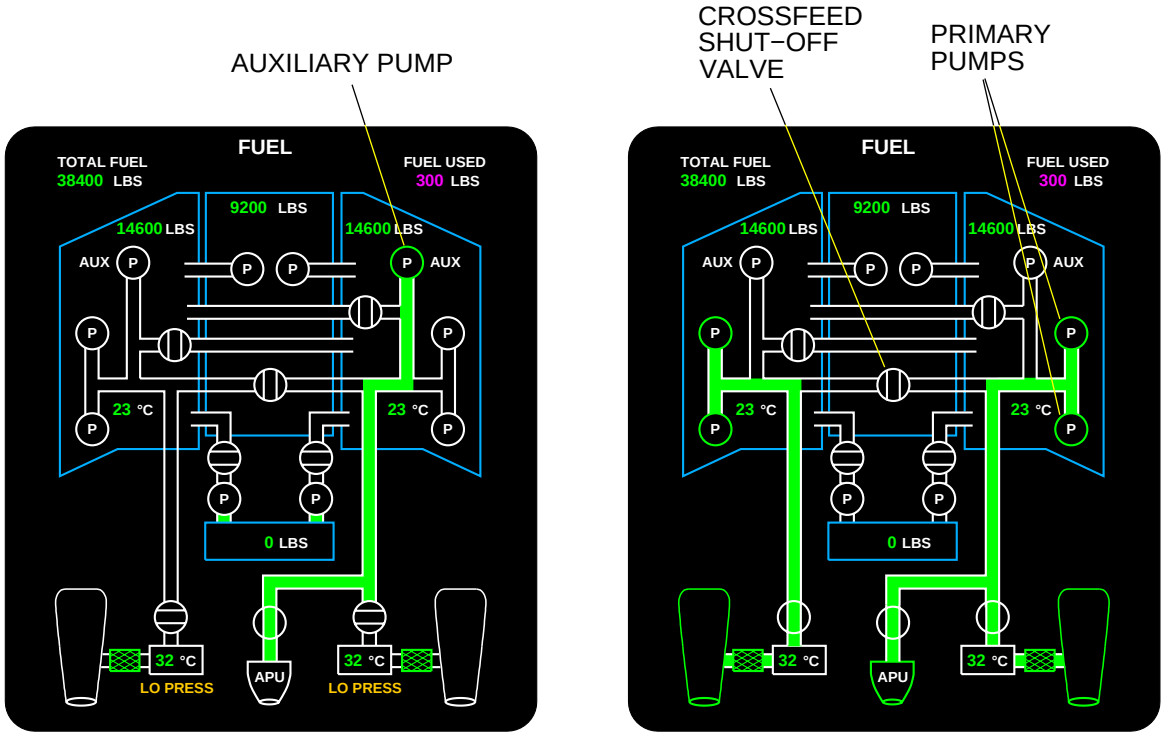
FUEL CONTROL AND INDICATION

The fuel system is a fully automatic electronic control system. The fuel control unit provides metered fuel to 10 fuel dual orifice nozzles regulated by signals received from the FADEC.

During start, the fuel system provides the correct amount of fuel to support combustion and for smooth acceleration of the engine to full rated speed. Once rated speed is reached, fuel flow is modulated as necessary to meet the demands of varying pneumatic and electrical loads, while maintaining a constant speed.

Airframe Fuel

Fuel is normally supplied to the APU from the right engine feed line or from the left engine feed line by opening the crossfeed shut-off valve. The left example below represents APU start operation with battery electrical power. The right example below represents APU on-speed operation with AC electrical power. For further information on the airframe fuel system operations, refer to the FUEL SYSTEM Chapter of this manual.



APU starting and no main engines running: The right AUX pump supplies the APU through the right engine feed line.

APU on−speed and main engines running: The right PRI pumps feed the APU through the right engine feed line.

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FUEL CONTROL AND INDICATION (CONT'D)

Ignition

The ignition system consists of a dual output ignition unit, two (2) ignition leads and two (2) igniter plugs. There are two cycles of operation: “BURST” for starting (at 5%) and “MAINTENANCE” for acceleration (duration of the start).

The ignition system is fully automatic and controlled by the FADEC. Ignition occurs at 5% APU RPM.

During APU operation in non-essential mode (ground operation), ignition is terminated at 50% RPM. During essential mode (in flight), ignition is terminated at 98% RPM.

Should flameout occur during operation, the ignition unit will automatically start through the “Auto Relight” function of the FADEC.

Start System

Operation of the starter is automatically controlled by the FADEC, through the APU control switch.

Starter operation begins by selecting the START position on the APU control panel. At sea level, starter cutout occurs at 46%. At altitude, starter cutout may be as high as 60% APU RPM to ensure a positive start.

The starter is capable of an immediate restart on roll down when APU RPM is at or below 7% RPM.

Speed Indication

Two speed sensors provide indicated speed for on-speed control and overspeed APU protection.

During operation, the FADEC monitors the input and should either sensor fail, there will be an APU FAULT advisory message displayed on EICAS.

A failure of either sensor will not cause an APU protective shut down to occur.

Temperature Indication

The EGT system consists of a single temperature sensing unit with two (2) probes. The probes provide redundant signals to the FADEC for fuel schedule trim, turbine temperature monitoring and Load Control Valve (LCV) modulation. The APU is protected from overtemperature during acceleration by protective features incorporated in the FADEC.

Loss of one probe will not affect APU operation.

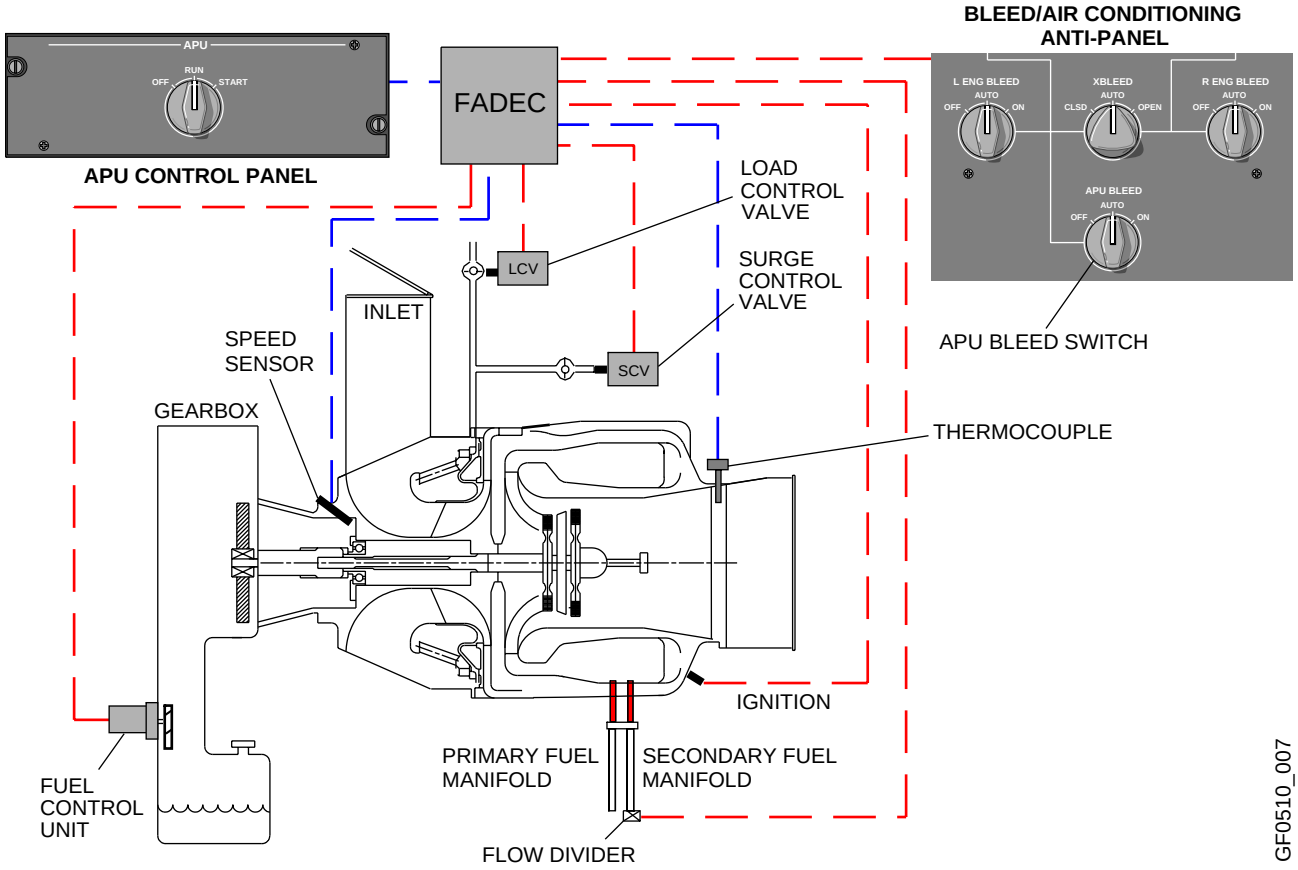
In the non-essential (ground) mode, failure of both probes will cause the FADEC to shut down the APU and inhibit start.

In the essential (in flight) mode, failure of both probes will not cause a shut down. Instead, the FADEC programs a preset signal to allow pneumatic loading and normal operation of electrical power.

Hourmeter/Cycle Counter

An hourmeter is powered on at 95% RPM and records the running hours of the APU. It is deactivated when APU shutdown is initiated.

ECU COMPONENT CONTROL SCHEMATIC



Control System

The APU electrical control system consists of two major sections: FADEC and electrical accessories. The FADEC is designed to execute precise control of the APU. Programming within the FADEC controls the APU through all modes and operating conditions. The FADEC monitors EGT, rpm, oil pressure, oil temperature and provides output signals for information display on EICAS. The electrical accessories are used, in conjunction with the FADEC, to perform sensing/control functions required for safe reliably starting and continuous monitoring of the APU.

Pneumatic

The pneumatic bleed load system consists of the LCV, connected to the bleed ducting and is normally modulated by the FADEC. The LCV can either be controlled automatically by the bleed management control system (AUTO selection) or manually by the APU BLEED switch (ON selection) on the BLEED/AIR COND/ANTI-ICE panel. The LCV will not open if:

- Manually selected ON and anti-ice is active.
- The left engine pressure regulating valve is open.
- The right engine pressure regulating valve and the crossbleed valve are open.

A Surge Control Valve (SCV) controls the APU surge potential when operating at altitudes above 15,500 ft. The system gives priority to AC generator loads in the event of a combined generator/pneumatic power overload condition. The SCV closes in flight for main engine starting or PACK operation.

APU SYSTEM OPERATING MODES

The APU system operating modes are as follows:

ECU Power-up

The ECU enters a power-up mode when the airplane BATTERY MASTER switch is selected to ON. It does a test of its circuitry to verify that it is capable of executing the APU control requirements for operation.

Start Mode

Upon receiving an active start signal and successful completion of the pre-start test sequence, the FADEC will initiate an APU start. During the start mode, the FADEC activates the fuel request signals, positions the APU door, activates and/or deactivates the starter and ignition control systems. It also controls fuel flow as a function of timed acceleration and EGT schedule as the APU accelerates to 100 percent.

On-speed Mode

When the APU reaches 95 percent speed, the FADEC transitions to the On-speed Mode to control governed speed and load control activation.

Cooldown Mode

With the APU operating in the On-speed Mode, the FADEC transitions to the Cooldown Mode when the APU switch is selected OFF. Upon entering this mode, the load control valve is closed and the ready to load signal is removed. During cooldown, the APU speed is lowered to 70 percent RPM for 60 seconds below 20,000 feet or remains at 100 percent RPM for the 60 second cooldown above 20,000 feet.

Shut down Mode

Upon completion of the cooldown period or in the event of a protective shut down, the FADEC transitions to the Shut down Mode and controls the APU shut down sequence.

APU SYSTEM OPERATING SEQUENCE

The following events occur when the APU is selected from RUN to START position:

APU Starting

The APU can operate with battery power only. The APU is started automatically when the START switch on the APU control panel is selected and held for one second. The RUN position commands the APU fuel SOV and right DC auxiliary pump to energize. The START position is spring loaded to RUN from the start position. When the door is correctly positioned, the FADEC engages the starter. When the speed reaches 5 percent, fuel and ignition are activated. At 50 percent speed, the starter disengages. For ground starts, ignition is deactivated at 50 percent. In flight, ignition is deactivated at 98 percent.

APU Door Positioning

The APU door is positioned automatically as a function of Weight-On-Wheels (WOW), Mach number and APU speed. When RUN is selected on the APU control panel and the airplane is on ground, the APU door is commanded to the full open position. When the airplane is in flight, the FADEC schedules the door position.

APU SYSTEM OPERATING SEQUENCE (CONT'D)

APU Loading

The FADEC controls the ready to load signals, one for electrical loading and one for pneumatic loading. Electrical loading is activated 2 seconds after the APU speed reaches 99 percent. If the APU drops below 95 percent, electrical loading is not available (on ground and in flight).

On ground, pneumatic loading is available 60 seconds after the APU reaches 99 percent.

In flight, pneumatic loading is available 2 seconds after the APU reaches 99 percent.

The APU LCV is opened upon receiving a bleed air request from the airplane bleed management control system or the APU BLEED switch on the BLEED/AIR COND/ANTI-ICE panel is selected. Open and closed positions of the control valve are determined by the status of weight-on-wheels, main engine starting and environmental control system signals. The bleed and load management systems are responsible to ensure that the bleed air request is activated only when another source of bleed air is not commanded. Example: L engine bleed valve open and/or the R engine bleed valve open and crossbleed valve opened (control valve remains closed).

The normal position for the APU BLEED switch is AUTO position. The AUTO position automatically integrates control of the APU LCV and the engine bleed has priority. The manual ON or OFF position will command the LCV to open or close as selected.

APU Shut down

When the “OFF” position on the APU control panel is selected, the FADEC controls the shut down sequence. The ready-to-load signals are cancelled, commanding the APU load valve closed and reducing the APU speed to 70 percent (below 20,000 feet) or 100 percent (above 20,000 feet) for a 60 second cooldown period.

NOTE

If the APU switch is selected to RUN prior to completion of the 60 second cooldown period, the APU returns to 100 percent and continues normal operation.

After cooldown is completed, the APU FADEC shuts down the APU and all loads and fuel demands are cancelled. When the speed drops below 25 percent, the inlet door is closed, APU operating hours and fault information are stored in the FADEC and the APU indications are removed from EICAS.

If the BATT MASTER switch is selected OFF, fire handle is pulled, or either APU shut-off switches (External Services Panel or APU compartment) is selected, the APU FADEC will cancel the cooldown period and initiate an immediate shut down.

APU DOOR OPERATION AND INDICATION

The APU door operation and EICAS indication displays are as follows:

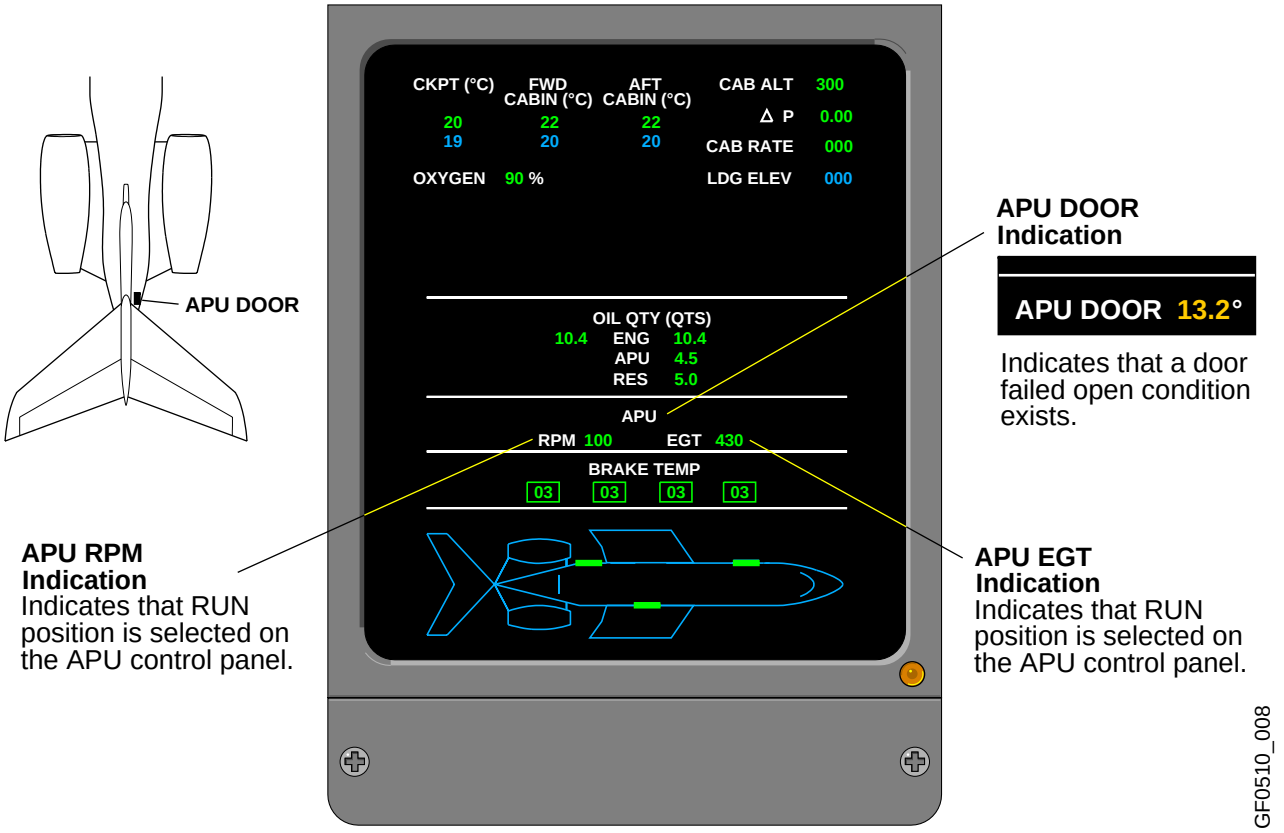
Door Operation

The APU inlet door is located on the upper right fuselage area. It is electrically actuated and is scheduled opened by the FADEC when the APU control switch is selected to RUN. The door will be commanded to 100% open for start and on-speed condition for ground operation. In flight prior to start, the inlet door will be positioned to either 10 degrees open at 0.85 MACH or 20 degrees open at 0.40 MACH. The door remains in either position until the APU reaches 20% speed and then will begin to gradually open until the door has reached the full open position and remains there.

The inlet door will be commanded to the closed position by the FADEC when the speed drops below 25% on shut down.

Door Indication

The APU door position is displayed on the EICAS STAT page. It is only indicated when there is a door fault and appears in conjunction with the " APU DOOR FAIL" caution message. The numerical readout is amber when a door fault exists as sensed by the FADEC.

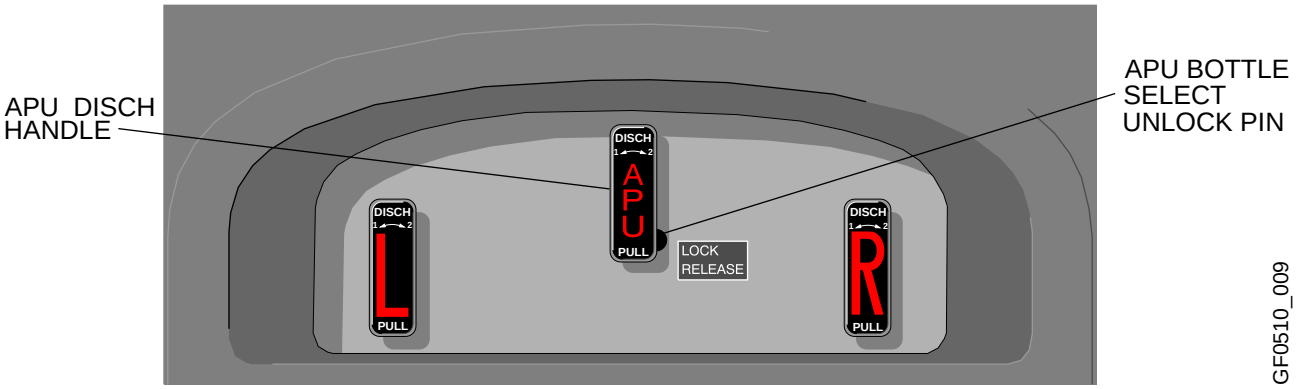


APU RPM and EGT Indications

For normal operations, the two APU parameters (RPM, EGT and corresponding numerical values) are displayed on the status page when the RUN position is selected on the APU control panel. The display remains active until APU speed drops below approximately 5% and the APU door is closed with the APU switch selected to OFF. The numerical readouts change to red when their limit values (refer to FCOM CSP 700-6 VOL 1, Chapter 2 LIMITATIONS) are exceeded.

APU FIRE PROTECTION

When the APU fire DISCH handle is pulled, the electronic control unit initiates an immediate APU shut down (with no cooldown period) and sends a signal to display the APU SHUTDOWN advisory message. When the APU fire handle has been pulled, then turned, the fire extinguishing bottle is discharged. If necessary, a second fire extinguishing bottle can be discharged (fire handle pulled) by displacing the fire handle unlock pin and turning the fire handle in the opposite direction.



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WARNING

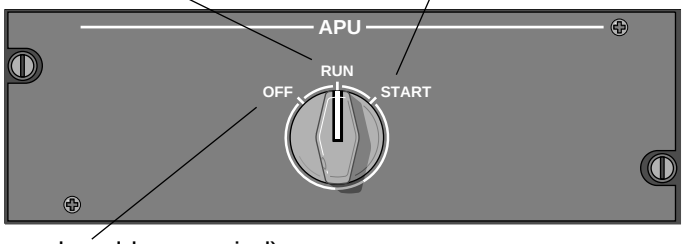
The APU must not be left unattended during ground operations.

Although there are protective shutdown features for the APU, there is no automatic discharging of the fire agent in the event of a fire. The APU must not be left unattended for ground operation. Refer to FIRE PROTECTION Chapter of this manual for information on APU fire protection system.

APU CONTROL PANEL

RUN
- Initiates the APU prestart BITE.
- On ground, commands the inlet door to full open
- In flight, commands the inlet door to open to either 10% (0.85 MACH) or 20% (0.40 MACH)
- Activates the flight compartment displays (oil quantity, speed and RPM).
- Starts the fuel pump.

START
- Fuel and ignition on at 5%.
- Starter disengage at approximately 50% RPM.
- Ground − ignition off at 50% RPM.
- In flight − ignition off at 98% RPM.
- Accelerates to 100% RPM.



OFF (APU enters a 60 second cooldown period)
- RPM decreases to 70% RPM for 60 seconds (below 20,000 ft.) remains at 100% above (20,000 ft.).
- After 60 seconds, the RPM will continue to decrease and fuel will stop at this time.
- Below 25% RPM the inlet door closes.
- Below 5% RPM the EICAS displays and indications are removed.

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START SEQUENCE

The APU requires 28 VDC to start. APU start is automatic, following switch selections of RUN and START on the APU control panel.

The start sequence is initiated by selecting the APU control switch to RUN:

- APU speed and EGT indicators appear on the EICAS secondary display.
- Activates fuel request signals.
- APU IN BITE (on ground only) status message comes on.
- APU inlet door opens (on ground).
- APU IN BITE (on ground) advisory message goes out (approximately 10 seconds).

Select the APU control switch to START position (spring loaded from START to RUN) for greater than one second and note the following:

- In flight the inlet door opens and “APU IN BITE” message annunciates.
- At approximately 5% speed, fuel and ignition occur.
- Between 50 and 60% the starter disengages.

NOTE

At 99% RPM plus 2 seconds, the APU is ready to load electrically.

At 99% RPM plus 60 seconds on ground or 2 seconds in flight, the APU is ready to load pneumatically.

- RPM accelerates to 100%.

NORMAL SHUT DOWN

Select the APU control switch to OFF (the APU enters a cooldown period) and note the following:

- RPM decreases to 70% RPM for 60 seconds or remains at 100% (above 20,000 ft.).
- After 60 seconds fuel is terminated and the RPM will decrease rapidly.
- Below 25% RPM the inlet door closes.
- Below 5% RPM speed and EGT indications are removed from EICAS display.

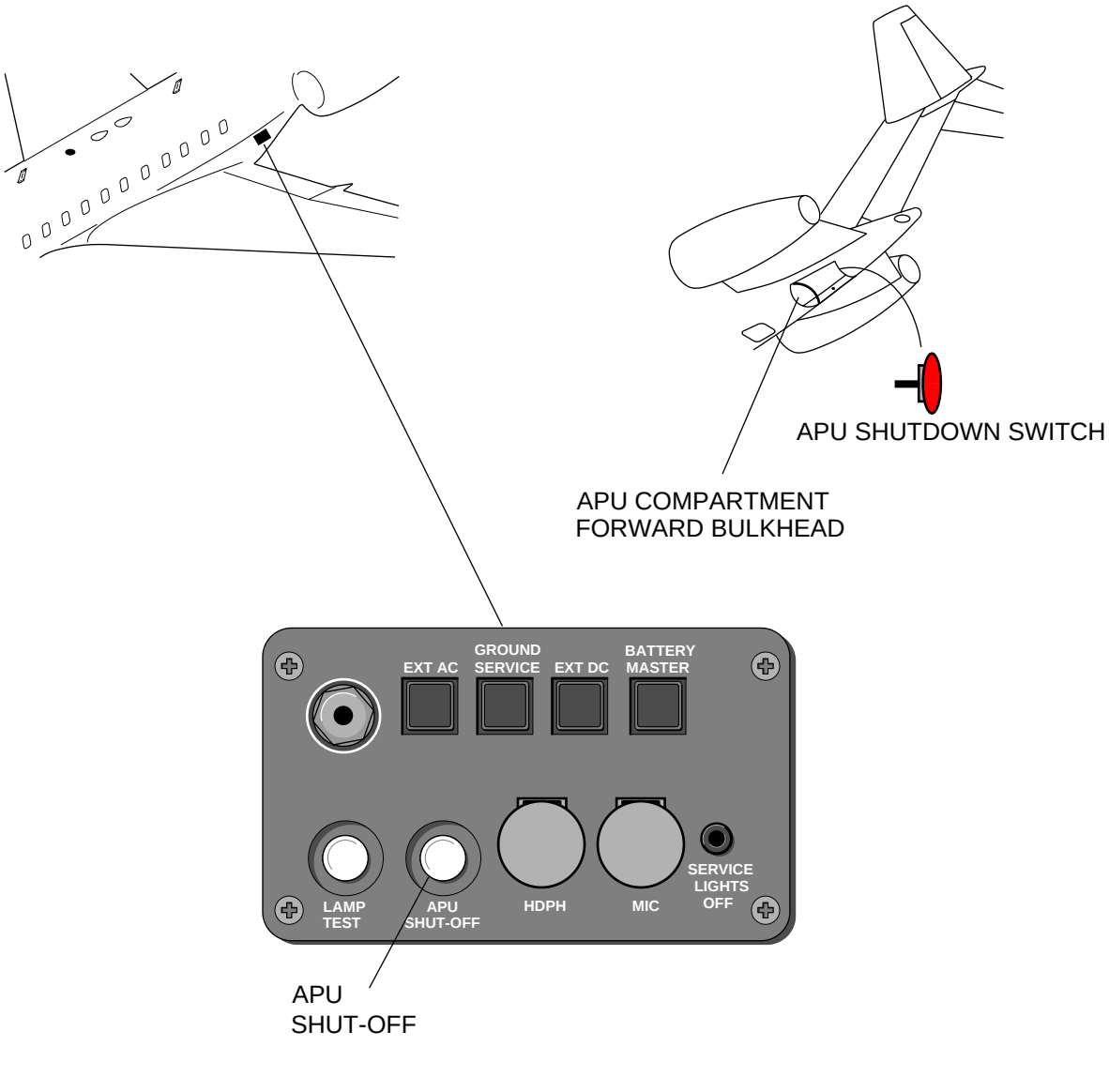
EMERGENCY SHUT DOWN

The following methods are considered not normal shut down procedures, but may be used in an emergency situation. Actioning any or all of these procedures will result in immediate shut down.

Carrying out any of the following shut down procedures will cancel the “cooldown” mode and shut down will occur immediately.

- BATT MASTER switch select to OFF (on the ground).
- APU DISCH handle pulled.
- APU SHUT-OFF button on the external services panel or APU SHUTDOWN SWITCH, located inside the APU compartment (on the forward bulkhead) is pushed in momentarily and released.

APU EMERGENCY SHUT-OFF BUTTONS



RESTART AFTER EMERGENCY SHUT DOWN

In order to restart the APU following an emergency shut down procedure, two conditions have to be met:

- The BATT MASTER switch has to be in the ON position.
- The switch on the APU control panel must be placed to the OFF position, before moving it to the momentary START position.

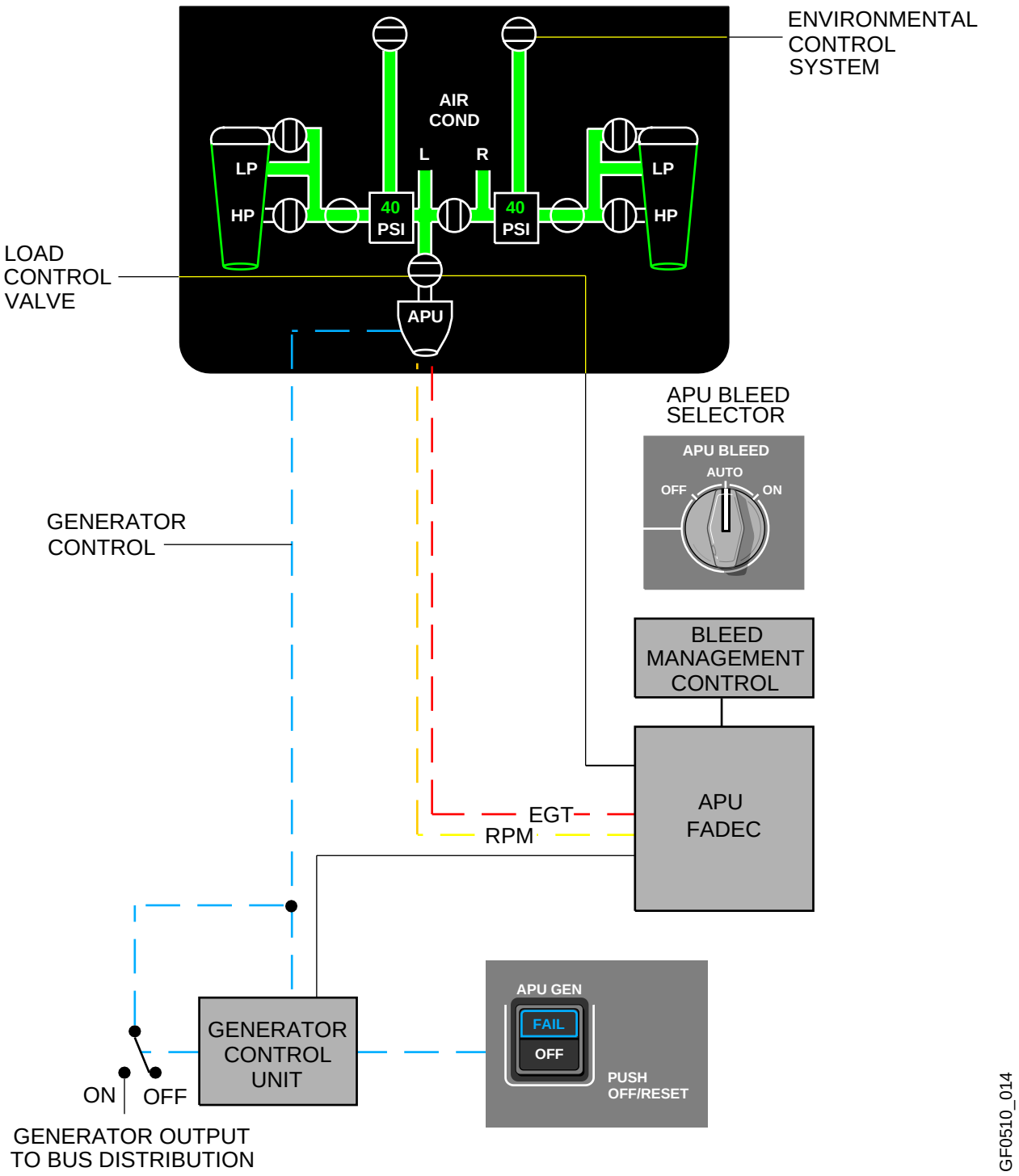
PROTECTIVE SHUT DOWNS

The FADEC will automatically shut down the APU when any of the following are detected:

SHUT DOWN CONDITIONS	GROUND	FLIGHT
NOTE: An **X** in one or both right columns indicate when shutdown can or will occur.		
FADEC Failure − Internal failure.	X	X
Inlet Door − Not in commanded position.	X	X
Loss of Overspeed Protection − Loss of any combination of speed sensors, FADEC overspeed circuitry or fuel solenoid that results in a loss of both overspeed systems.	X	X
Overspeed − APU speed greater than 106 percent.	X	X
Loss Of Speed − Loss of both APU speed signals.	X	X
Fire − Fire input signal received by FADEC.	X	
DC Loss − Loss of DC power to the FADEC.	X	X
Slow Start − No crank, slow start, no acceleration, no flame or fallback (Starter cutout speed and subsequentially drops below 25 percent).	X	X
High Oil Temperature − Oil temperature limit exceeded.	X	
Low Oil Pressure − Low oil pressure condition detected.	X	
LOP Switch Fail − Low oil pressure switch failed.	X	
Loss of Both EGT Sensors − Failure of both EGT thermocouples.	X	
Reverse Flow − APU inlet temperature exceeded.	X	
Underspeed − APU drops below 80 percent.	X	
Overtemperature − EGT exceeds scheduled limits.	X	

SYSTEM OVERVIEW SCHEMATIC

BLEED AIR/ANTI-ICE SYNOPTIC PAGE



ELECTRICAL POWER AND DISTRIBUTION

The electrical control of the APU consists of electrical sensing, starting, ignition and the electronic control system through the FADEC.

APU electrical power may be used in flight or on ground. Electrical power is extracted from the APU in the form of horsepower which drives the APU generator and may be used to feed the airplane electrical power system.

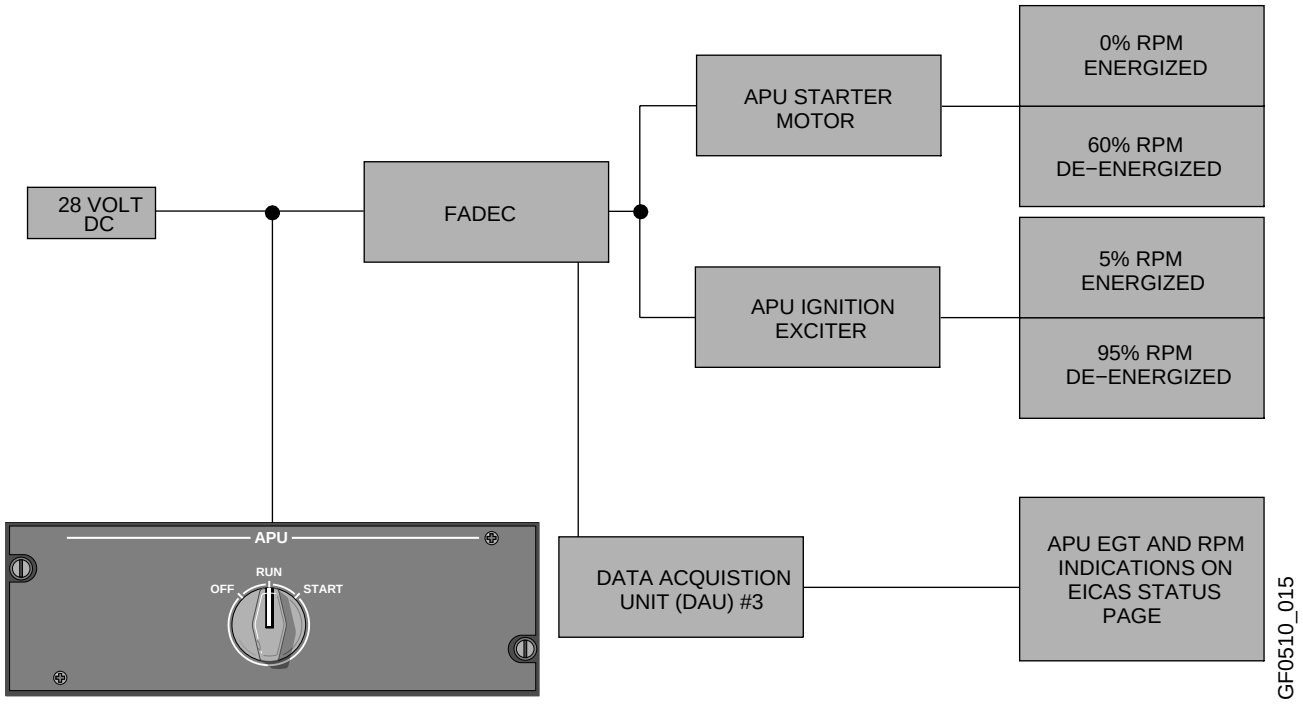
Under high electrical load demands, the APUs electrical loads take priority over pneumatic load demands.

The FADEC is mounted remotely from the APU in a compact enclosure located in the aft equipment bay.

The FADEC is powered up when the BATT MASTER switch is selected ON. The BATT MASTER switch powers the airplane battery bus, which provides electrical power to the FADEC.

The FADEC uses the APU acceleration rate to calculate when to de-energize the starter motor and the ignition exciter. The values shown (START CONTROL SCHEMATIC below) are the maximum speeds at which the starter motor and the ignition exciter are permitted to operate.

START CONTROL SCHEMATIC



The FADEC control outputs include fuel metering, arming and regulation of the LCV and control of the surge valve. It also performs protective shut downs when the APU is not within allowable operating limits.

A built-in-test capability of the FADEC tests components for serviceability and initiates the start sequence. It also enables reliable fault isolation within the system.

START CONTROL SCHEMATIC (CONT'D)

FADEC Inputs and Outputs

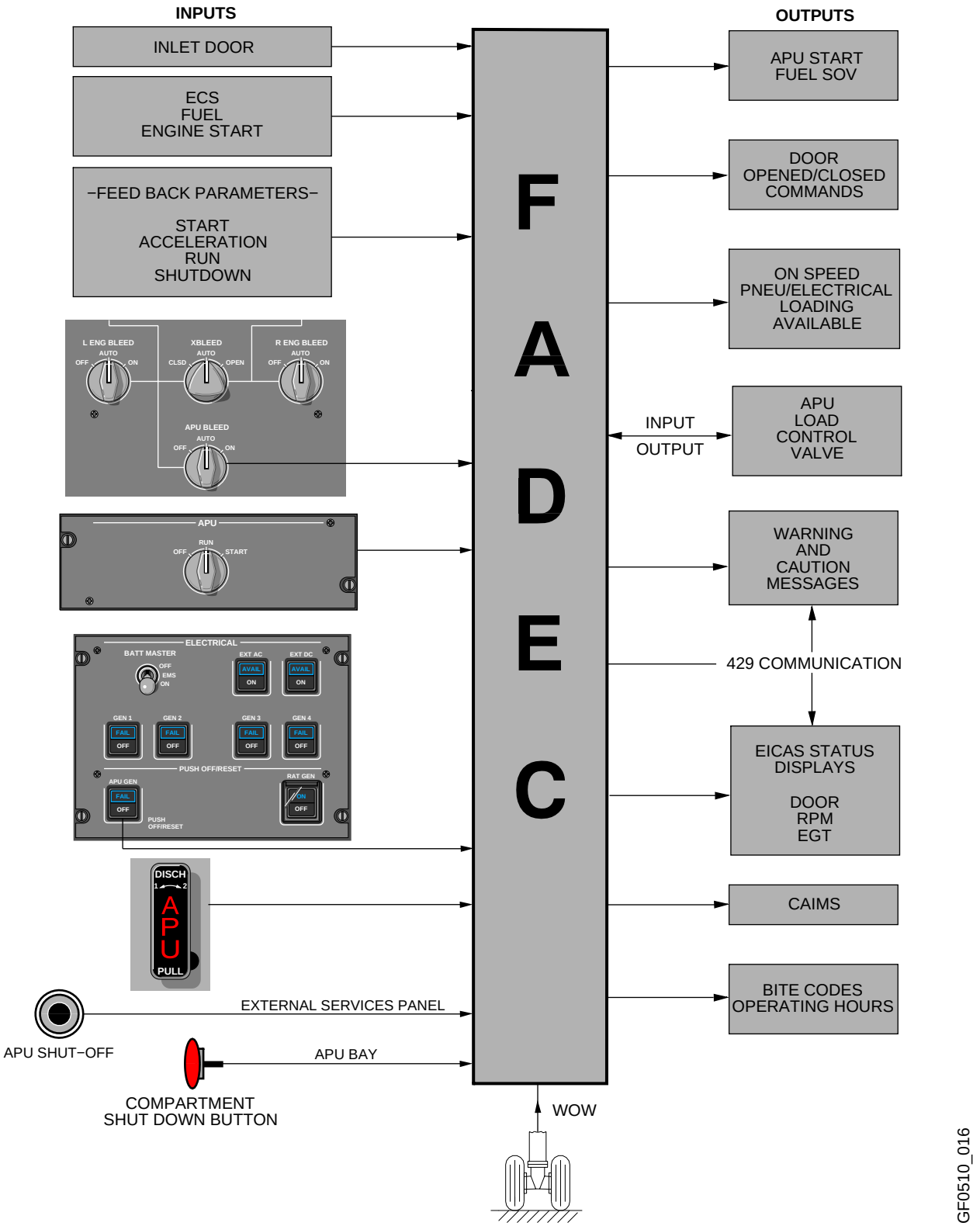
The following are input signals received by the FADEC:

- 28 VDC power, supplied by the APU Battery Direct Bus (the Avionics Battery Direct Bus is used as a backup).
- ECS, fuel and engine start.
- Inlet door position.
- Feedback of all applicable parameters during start, acceleration, run and shut down.
- Fuel, bleed/air conditioning, anti-icing, engine start and electrical control panels.
- APU FIRE DISCH handle, APU SHUT-OFF (external services panel and APU bay) and WOW status.

The following are outputs generated by the FADEC:

- APU start and fuel feed shut-off.
- Door open and close operations.
- On speed loading of pneumatics/electrics.
- ARINC 429 Communication signals to EICAS.
- Interface with CAIMS.

ECU SCHEMATIC

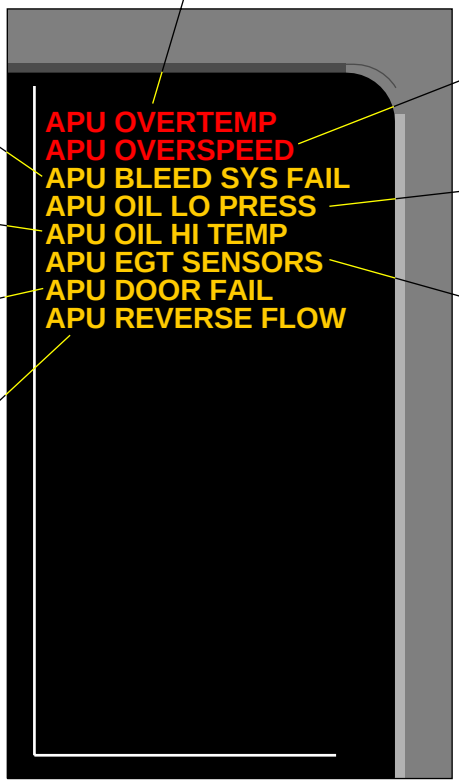


EICAS MESSAGES

APU OVERTEMP
Indicates that an EGT over temperature exists.

APU BLEED SYS FAIL
Indicates that the APU LCV does not match command position or bleed failures are detected by the bleed management computer.

APU OVERSPEED
Indicates that an APU overspeed protective shut down has occurred.



APU OIL LO PRESS
Indicates that a low oil pressure condition exists.

APU OIL HI TEMP
Indicates that a high oil temperature condition exists.

APU EGT SENSORS
Indicates both thermocouples have failed.

APU DOOR FAIL
Indicates that the APU door position does not match command position.

APU REVERSE FLOW
Indicates that a reverse flow from the engine bleed(s) to the APU exists.

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EICAS MESSAGES (CONT'D)

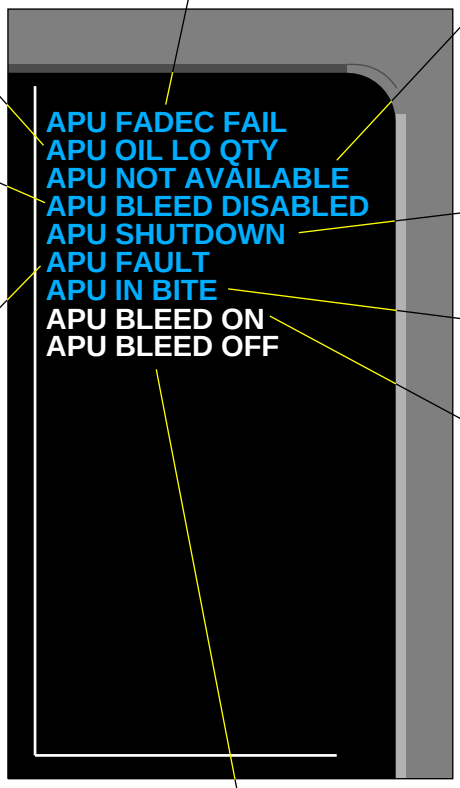
APU FADEC FAIL
Indicates that no data is received by the DAU.

APU OIL LO QTY
Indicates that the APU oil level has reached 3.5 quarts (2 quarts low).

APU NOT AVAILABLE
Indicates that when START or RUN is selected, checks/testing is in progress.

APU BLEED DISABLED
Indicates that the LCV command has been received and either:

- The inlet pressure is less than 3.3 psia (35,000 ft).
- The 60 second warm−up period (on ground only) is in progress.



APU SHUTDOWN
Indicates that an APU protective shut down has occurred, other than an overspeed or over temperature.

APU IN BITE
Indicates that RUN is selected and the prestart BITE is in progress.

APU FAULT
Indicates a failure in one of the following:

- Single speed sensor.
- EGT thermocouple.
- Fuel solenoid (failed to close).
- Fuel/oil filters in impending by−pass.
- Low oil pressure switch has failed (in flight).

APU BLEED ON
Indicates that the APU BLEED switch is in the ON position and the load control valve is open.

APU BLEED OFF
Indicates that the APU BLEED switch is in the OFF position and the load control valve is closed.

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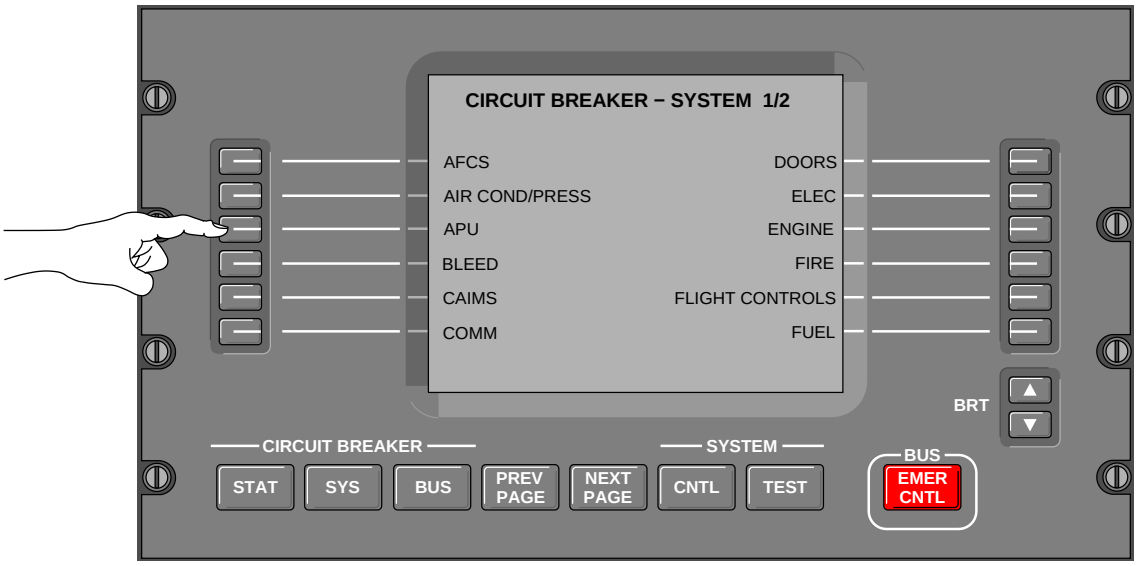
CB - APU SYSTEM



CB – APU SYSTEM			1/1
APU DOOR	APU BATT	ASCA	IN
APU FADEC PWR 1	BATT		IN
APU FADEC PWR 2	AV BATT	DCPC	IN
APU OIL HEAT	AC 4		IN
APU START	BATT		IN
APU START CONTACT	APU BATT	ASCA	IN

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