

DASSAULT FALCON 7X

SYSTEMS SUMMARY



Auxiliary Power Unit

This material is to be used for training purpose only

Do not use it for flight!

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Falcon 7X [APU Summary]

ACRONYMS LIST

AMSAC	Air Management System Automatic Controller
APU	Auxiliary Power Unit
BAS	Bleed Air System
CAS	Crew Alerting System
CMC	Central Maintenance Computer
CMS	Central Maintenance System
DC or dc	Direct Current
DCU	Data Collection Unit
EB	Electronic Box
ECS	Environmental Control System
ECU	Electronic Control Unit
EGT	Exhaust Gas Temperature
FCP	Fire Control Panel
FCU	Fuel Control Unit
FSOV	Fuel Shut Off Valve
GCU	Generator Control Unit
LH	Left Hand
LCV	Load Control Valve
LRU	Line Replaceable Unit
OP	Overhead Panel
PDCU	Primary Distribution Control Unit
PPDB	Primary Power Distribution Box
RH	Right Hand
RTL	Ready To Load
S/G	Start / Generator
SCV	Surge Control Valve
SOV	Shut Off Valve
SSPC	Solid State Power Controller
WOW	Weight On Wheels

INTRODUCTION

The Falcon 7X is equipped with a HONEYWELL 36-150 [FN] Auxiliary Power Unit (APU).

The APU is a gas turbine engine that provides:

- Bleed air for the Environmental Control System and main engine starting,
- Mechanical energy for driving the APU Starter/Generator (S/G) to provide electrical power to the airplane.

The APU is for ground operation only.

The APU operation is electronically controlled.

FLIGHT DECK OVERVIEW

CONTROLS

Crew controls of APU is performed via:

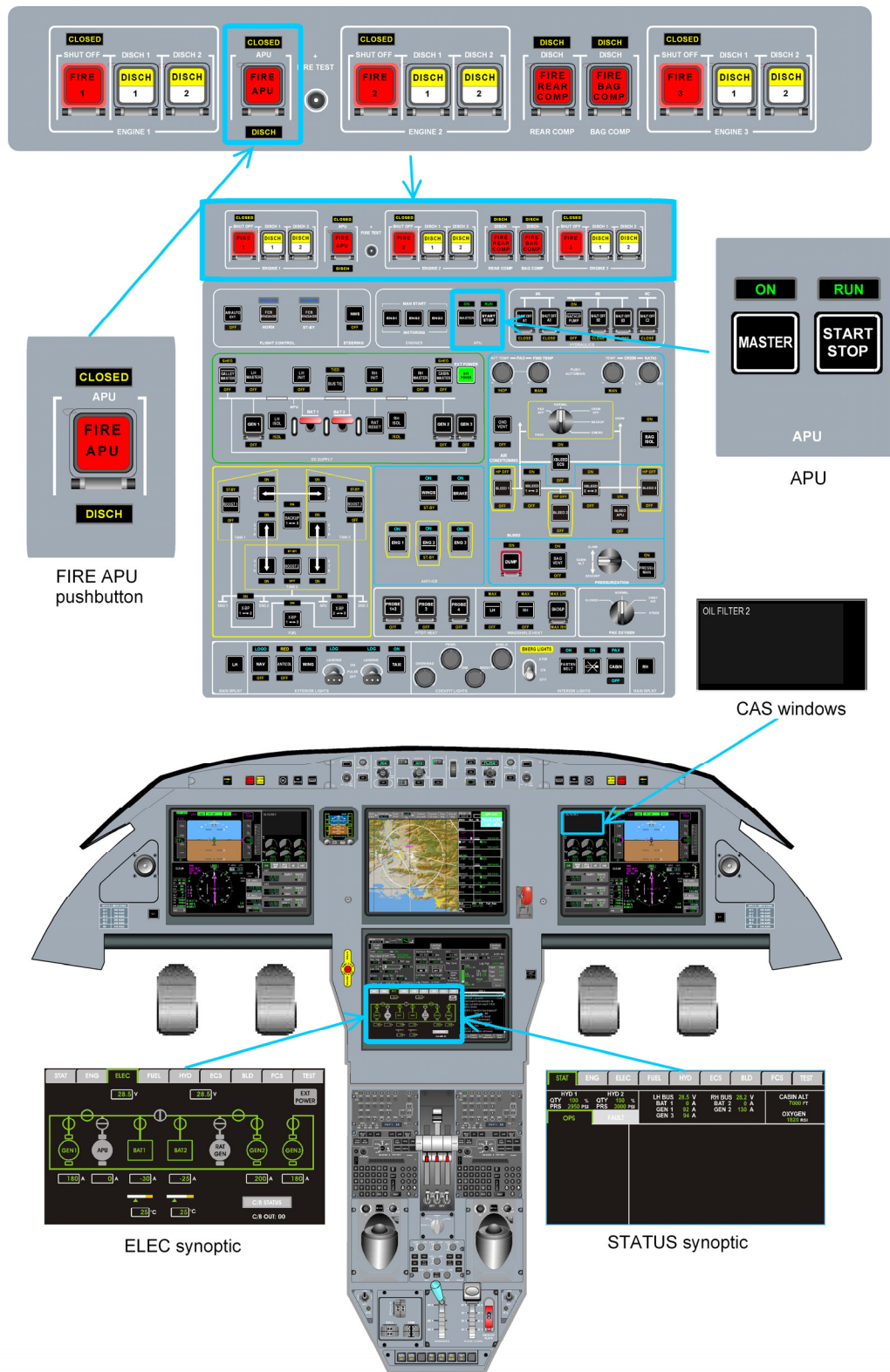
- The APU portion of the overhead panel,
- The APU FIRE Push Button on the Fire Control Panel.
- The SERVICING page accessible in the TEST Synoptic page.

INDICATIONS

Cockpit indications related to engine system are displayed on:

- Systems feedback on the Overhead Panel,
- ELEC synoptic page (for APU generator data) ,
- ENG synoptic page (for APU parameters),
- ENG-FUEL-TRM window (for APU parameters),
- The ENG-CAS window for CAS messages,
- The STATus synoptic / FAULT tab for fault messages.

Falcon 7X [APU Summary]



FLIGHT DECK OVERVIEW

GENERAL

The APU main parts are:

- A Power Section (compressor, turbine, combustion chamber, bearings),
- A Gear Box module,
- APU systems (fuel, lubrication, ignition and pneumatic system),
- APU Control and Indication system components: the APU control and monitoring is performed by an Electronic Control Unit (ECU).

APU SYSTEMS

OIL SYSTEM

The oil system provides lubrication of the main rotor bearings and accessory gearbox. Oil system includes a specific oil cooling system.

A thermostat, inside the oil sump, controls oil temperature.

FUEL SYSTEM

The airplane fuel system supplies fuel from TANK 2 to the APU via a boost pump and an APU Fuel Shutoff Valve (FSOV).

IGNITION SYSTEM

The APU ignition / starting system is fully automatic in operation and is controlled by the Electronic Control Unit (ECU).

APU ELECTRONIC CONTROL UNIT (ECU)

The APU is controlled by an Electronic Control Unit.

The ECU provides:

- Automatic management of APU operation,
- Protections by automatic shut down during starting sequence, operation phases and shutdown phases.

DISTRIBUTION

APU GENERATOR

The APU starter-generator is rated at 28.5 V / 400 A and is regulated by an associated Generator Control Unit (GCU) mounted in the rear compartment.

The APU starter -generator can power the entire DC electrical system in addition to charging batteries.

BLEED AIR

The APU bleed-air duct supplies APU bleed-air to the airplane pneumatic system, for ground air conditioning or airstart.

OPERATION

The APU is started using the DC Starter / Generator powered from battery No 1 connected to the LH Battery Bus.

The ECU automatically controls the APU to maintain the required speed and safe operating EGT throughout the start, acceleration, idle and full load operation.

Selected parameters are monitored for operational limits. If these limits are exceeded, the ECU automatically shuts down the APU.

DESIGN PRINCIPLE

The Auxiliary Power Unit APU design principle are:

With regard to Safety:

- The APU is enclosed in a composite fireproof enclosure fitted with drainage system avoiding build-up of hazardous fluids or vapors,
- The ECU provides auto-shut down protection during all operating mode,
- The FCP (Fire Control Panel) commands an Emergency auto shut down when fire is detected,
- The APU is controlled by an ECU which provides automatic operation and auto shut-down protection thus the crew does not have to monitor APU parameters continuously.

With regard to maintenance:

- The enclosure panel are removable to provide maintainability access to the APU compartment,
- The design of the enclosure, and the location of the LRU provides the necessary access for maintenance operation,
- APU Faults status is communicated to maintenance staff via ECU and CMC.

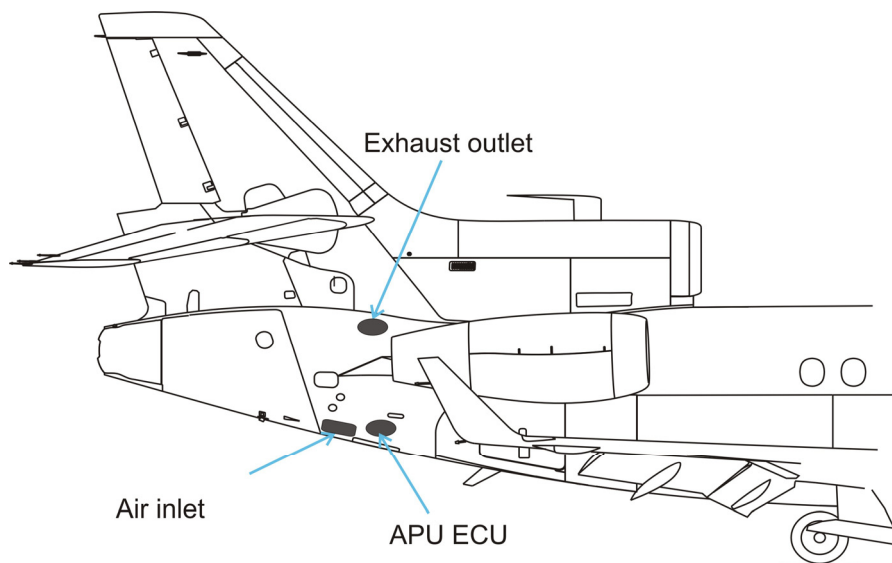
EQUIPMENT LOCATION

The APU is installed in the aft fuselage section of the airplane.

The APU is separated from the center engine bay and the maintenance bay by a carbon / titanium fireproof enclosure.

Air inlets are located on the RH and LH sides of the aft fuselage and are screened to prevent entry of significant size foreign material:

- The inlet for the APU engine is on the RH side,
- The inlet for APU shroud for cooling and exhaust gases dilution is on the LH side,
- The exhaust outlet is located on the upper RH side of the aft fuselage.



EXHAUST OUTLET AND AIR INLET

ELECTRICAL POWER SUPPLY

The following paragraph describes the power supply of the different equipment of the APU system.

Electrical protection is provided:

- By Solid State Power Controllers (SSPC) ,
- Or by Circuit Breakers (CB).

EQUIPMENT	POWER SUPPLY	TYPE OF PROTECTION
APU ECU	RH Essential	SSPC
APU IGNITION UNIT	RH Essential	SSPC
APU Fuel SOV	LH Essential / Battery 2	CB

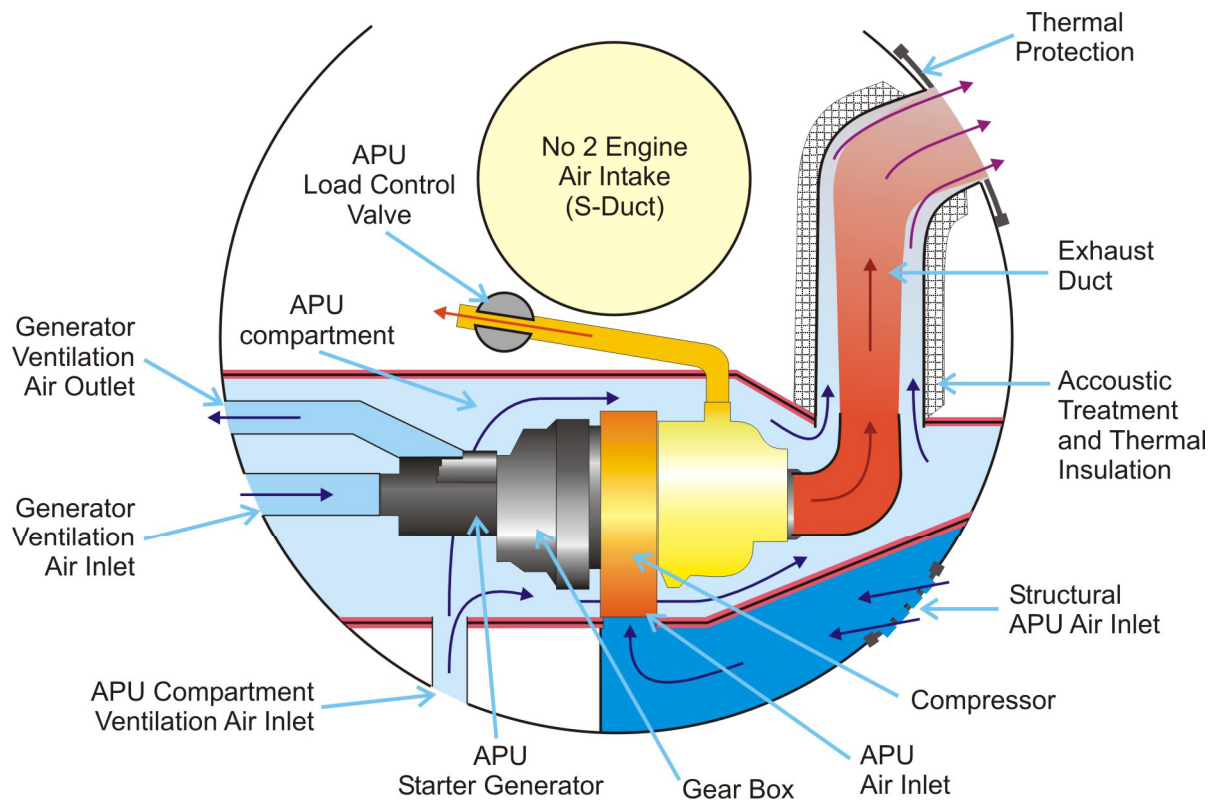
APU DETAILED DESCRIPTION

The APU consists of:

- An air intake, located in the middle of the unit which connects to a structural RH lateral air inlet,
- A centrifugal compressor and its bleed air port,
- A combustion chamber,
- A single stage turbine,
- A primary exhaust duct,
- A secondary exhaust duct acoustically treated and thermally insulated,
- An accessory section.

The accessories include:

- The APU fuel control unit,
- The fuel pump,
- The oil pump,
- The starter generator.



APU LAYOUT

APU SYSTEMS

FUEL SYSTEM

The airplane fuel system supplies fuel to the APU Fuel Control Unit (FCU) via BOOST Pump 2 (which feeds also the No 2 Engine) through a dedicated APU fuel line, and an APU Fuel ShutOff Valve (FSOV).

The FSOV opening and closing is managed by the APU ECU.

The APU fuel line is able to feed the engine n°2 (central) in the failure case when the engine n°2 line is cut.

IGNITION SYSTEM

The APU ignition / starting system is fully automatic in operation and is controlled by the Electronic Control Unit (ECU). This system consists of:

- The interface to the Starter / Generator and the GCU,
- An ignition unit,
- Two igniter plugs,
- Two igniter leads.

The functions of the ignition and starting system are as follows:

- Provide cranking power for APU starting,
- Provide ignition for combustion initiation,
- Disengage the APU starter motor at the appropriate APU speed.

Upon reaching 95% of N1, a signal from the ECU terminates the ignition.

APU ELECTRONIC CONTROL UNIT (ECU)

The ECU is located in the mechanic-servicing compartment.

APU operation is monitored through N1 signal generated by a magnetic sensor mounted on the accessory gearbox and a temperature signal (T5) generated by the single thermocouple probe installed in the APU exhaust duct.

The speed-governing loop continuously monitors N1 and modulates fuel flow-timed acceleration during starting of the engine or control during self-sustaining operation.

The temperature loop is not active during APU starting or normal operation unless exhaust duct temperature exceeds the maximum operating value.

DISTRIBUTION

The hot bleed air necessary for air conditioning is tapped downstream from the compressor.

OPERATION

The APU is started using the DC Starter / Generator powered from battery No 1 connected to the LH Battery Bus (battery 1).

During the APU start operation, the LH Battery bus is not connected to the LH Essential bus, as power to the LH and RH Essential buses is maintained by the No 2 battery or by the GPU.

The Starter / Generator is controlled by a Generator Control Unit (GCU), both during the APU start and power generation.

When the APU ECU is powered (by the crew members through the overhead MASTER p), it performs its BITE and opens the APU Fuel Shutoff Valve.

Then, when the crew members push the START pushbutton, the Starter / Generator is energized and begins rotating the APU. As the APU main rotor speed (N1) reaches approximately 5% (N1), the ECU commands the ignition unit Solid State Power Control (SSPC) closed and the APU fuel shutoff solenoid valve opened.

The ignition unit provides the electrical energy to create a spark across the igniter plugs.

As the APU reaches approximately 50% (N1), the starter circuit is de-energized by the ECU. Electrical energy to the ignition system is terminated at 95% (N1) APU speed.

As the APU reaches 95% (N1) of governed speed for more than 4 seconds, the ECU sends a Ready To Load (RTL) signal to the airplane system and the S/G can be commanded open to be loaded and provide electrical power to the airplane.

Then, a certain time after having reached 100% (N1) of governed speed, when the ECU estimates that the APU operates satisfactorily and is capable to be air bled, the ECU allows the Load Control Valve (LCV) to open in case the bleed request is sent by the ECS AMSAC, in order to provide bleed-air to the airplane pneumatic system.

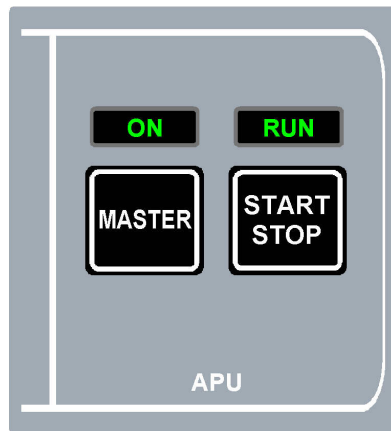
For a normal APU shutdown, the ECU simulates an APU overspeed.

CONTROLS

Crew controls of APU are performed via:








- The APU portion of the overhead panel,
- The APU FIRE pushbutton annunciator (Fire Control Panel),
- The SERVICING page accessible in the TEST synoptic page, to test the APU oil level.

APU PORTION OF THE OVERHEAD PANEL



APU SECTION OF THE OVERHEAD PANEL

Falcon 7X [APU Summary]

CONTROL	FUNCTION	TO ACTIVATE		SYNOPTIC
		TO DEACTIVATE		
	Powers the APU (APU not running and not powered)	Push to power before start-up		N1 and T5 values are not displayed
	Deactivates the APU (APU only powered and not running)	Push to deactivate		N1 and T5 values are displayed in the ENG synoptic page and ENG-TRM window.
	Abnormal APU stop or faulty Built-In-Test: - Blinking at 1 Hz: a pilot action on the MASTER pushbutton is possible or requested, - Blinking at 5 Hz: pilot action forbidden. The system is evolving automatically	No action		
	Initiates APU starting sequence when the ON light only is on.	Push to start		
	Initiates APU shutdown when both ON and RUN lights are on (APU running).	Push to stop		

Falcon 7X [APU Summary]

MASTER pushbutton:

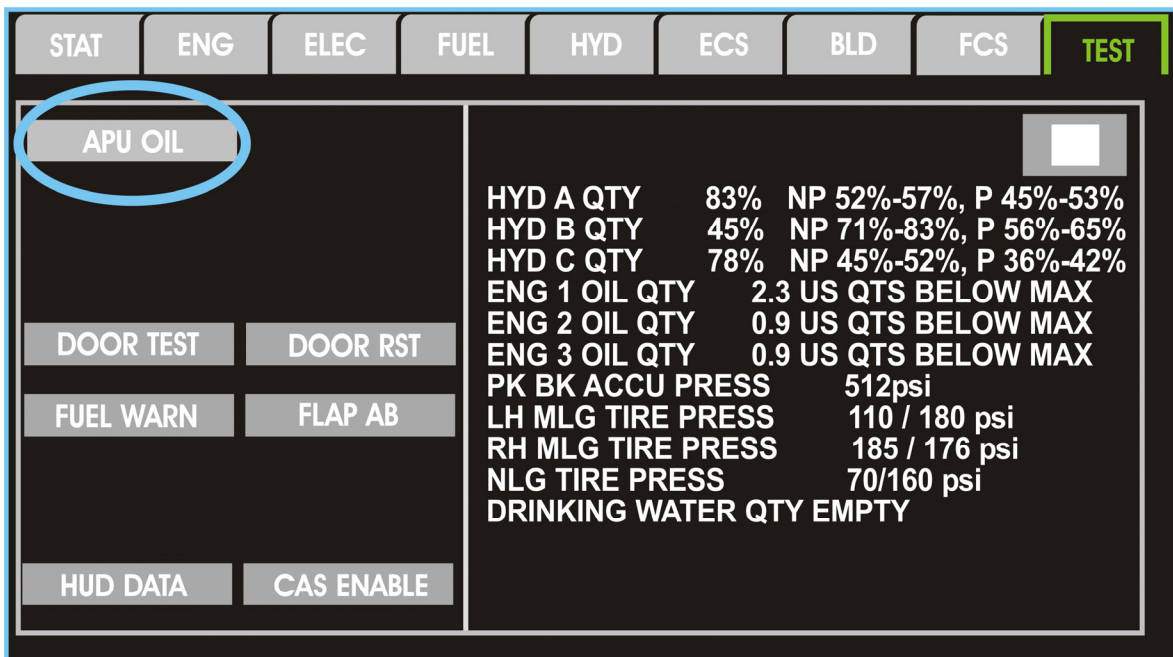
- Provide primary power to the ECU,
- Powers the aircraft Fuel Shut off open,
- Allow the ECU power up sequence ("ON" illuminated when ready).

The ON green light associated to the MASTER pushbutton is lighted when the APU is electrically powered.

The START STOP pushbutton command start stop sequence of APU operation. The RUN green light associated to START STOP pushbutton is lighted when the APU is running.

TEST SYNOPTIC PAGE

In the TEST synoptic page, APU OIL status can be obtained through SERVICING window.



SERVICING PAGE

The test must be performed once a day with the APU off and the RH MASTER being ON.

The system indicates:

- If APU oil level is valid: **LEVEL OK**,
- If APU oil level is too low: **ADD APU OIL**,
- If the oil data is invalid: **TEST FAIL**.

NOTE

An hour meter located in the servicing compartment, records APU operating time. It automatically begins to record as soon as the APU N1 reaches 97% N1.

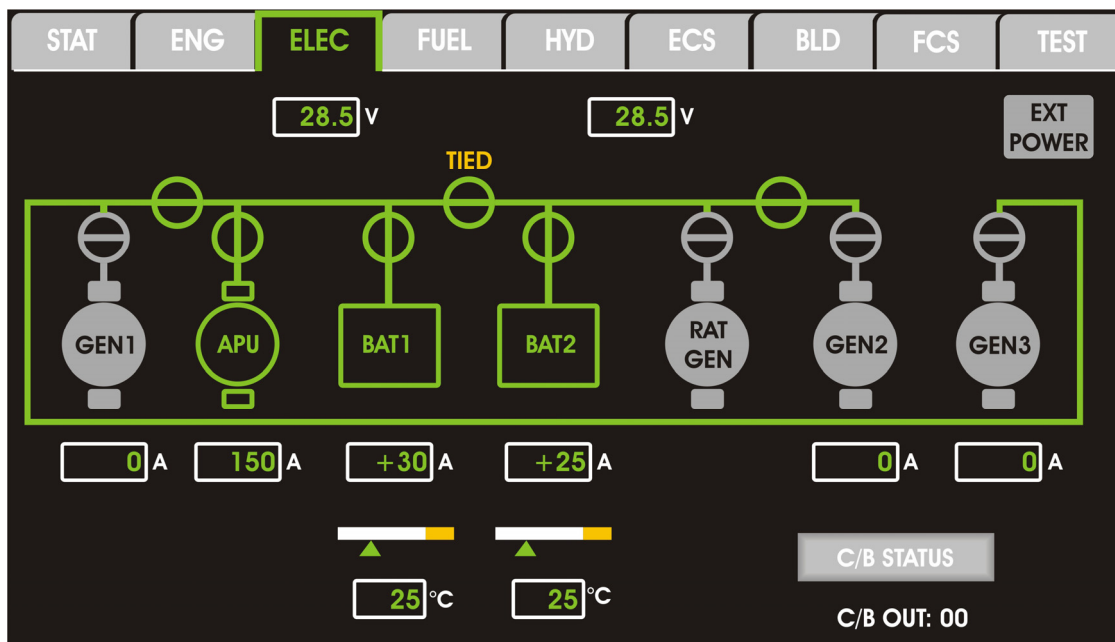
INDICATIONS

Cockpit indications related to APU are displayed on:

- The ELEC synoptic page (for APU generator status and ammeter measurement),
- The ENG-TRM window (for APU parameters)
- The ENG synoptic page (for APU parameters)

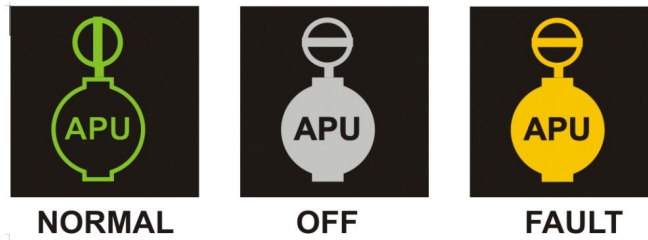
ELEC SYNOPTIC PAGE

As the APU supplies electrical power to the airplane, APU electrical indications can be displayed in the ELEC synoptic. This page indicates APU generator status and the corresponding ammeter measurement.



ELEC SYNOPTIC - APU RUNNING

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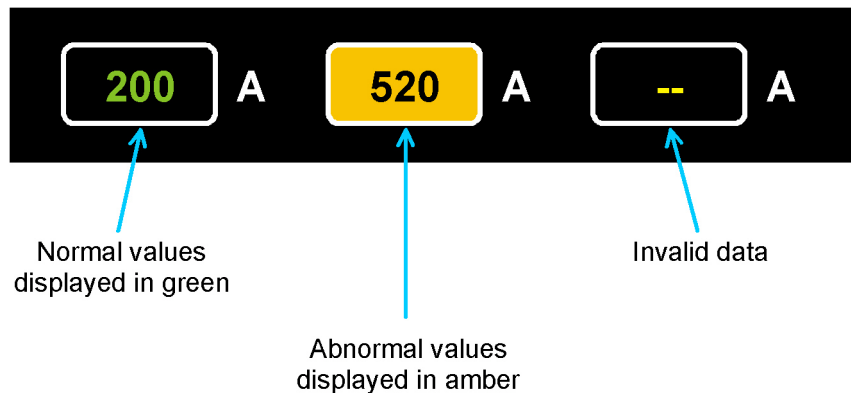


APU GENERATOR SYMBOL

The APU generator status can be:

- On line (green outlined synoptic), or
- Disconnected (gray outlined synoptic), or
- Failed (amber outlined synoptic).

The ammeter indicates normal operating values or abnormal values using the following rules.



APU AMMETER INDICATIONS

The digital readouts are only displayed when the airplane is on the ground with APU running. The range of the scale is amber above 400 A.

ENG-TRM WINDOW

APU engine parameters are displayed at the bottom of the ENG-TRM window.



ENG-TRM WINDOW

ENG SYNOPTIC

APU Engine parameters are also displayed at the top right hand corner of the ENG Synoptic.



APU INDICATIONS IN ENGINE SYNOPTIC

Falcon 7X [APU Summary]

N1 indications

APU N1 95 %

N1 between 0 to 102 %: normal APU start or operation. No crew members action required

APU N1 103 %

N1 between 102 % and 105.9 %: limited APU overspeed, APU can continue. Crew members to be careful

APU N1 --- %

APU speed unknown: crew members must check that the APU is auto shutdown

T5 indications

T5 600 °C

T5 below 870°C in normal operation (985°C at start up): normal APU start or operation. No crew members action required

T5 990 °C

T5 above 870°C in normal operation (985°C at start up): APU auto-shutdown due to overheat. Crew members must check that the APU is stopping.

T5 --- °C

Exhaust Gas Temperature unknown: crew members must check that the APU is auto shutdown

SYSTEM MONITORING

Following APU parameters are monitored:

- Any APU fault,
- APU Load Control Valve (LCV) fails to open when command.

ACTIVE PROTECTIONS

A protective automatic shutdown is initiated in case of:

- Fire,
- APU operating limit are exceeded,
- Loss of Weight On Wheel signal,
- Starter / Generator tripped off-line,
- ECS overheat.

ACTIVE PROTECTIONS

For a normal APU shutdown, the ECU simulates an APU overspeed. Therefore, the overspeed protection system included in the ECU is tested at each end of APU operation: it is the overspeed system test which avoids any dormant failure in this area.

For a protective shutdown, the ECU bypasses the above overspeed system test and immediately commands the FCU shutoff valve and torque motor metering valve closed.

For a real APU overspeed condition, both the ECU primary overspeed system and the software command the FCU shutoff valve and fuel metering valve closed.

The events leading to the automatic protective shutdown of the APU are the followings:

EVENT	DEFINITION
Over-speed	APU speed exceeds 105.9 %
High oil temperature	APU oil temperature exceeds 162°C (325°F) for 10 seconds with the APU operating
Loss of overspeed protection	Loss of primary over-speed protection
Reverse flow	APU inlet temperature exceeds 132°C (270°F) for 5 seconds with the APU operating and the LCV open
Loss of speed sensor signals	Failure of speed sensor channel
Under-speed	APU was operating and speed drops below 80% for 5 seconds
ECU failure	Internal ECU failure that could result in loss of APU control
Loss of EGT sensor	EGT sensor channel failed
No crank	APU start SSPC activated and no APU speed detected
APU fire/emergency	A signal received by the ECU from the fire protection system
No flame	Fuel and ignition activated and no light-off detected
Generator off-line	The generator has failed and the APU shuts down after 5 minutes

Falcon 7X [APU Summary]

EVENT	DEFINITION
No acceleration	Light off detected but fails to accelerate to governed speed
ECS Overheat	The ECS system experiences an overheat shutdown and the APU shuts down after 5 minutes
Loss of DC power	Loss of Battery Bus and Battery Direct Bus
Oil pressure switch failed	Failure of low oil pressure channel
Over-temperature	APU EGT exceeds schedule limits : EGT limit = f(speed), duration maxi = f(EGT - EGT limit): for example at 100% speed, EGT limit = 760°C (1400°F) and duration maxi is 4 seconds at 760°C
Low oil pressure	Low oil pressure condition active (lower than 26 psi) for 15 seconds with the APU operating
Loss of WOW signal	The APU shuts down automatically when the WOW is lost.

APU OIL FILLER PORT

