
APU
Presentation
OVRD
G
B
Y
APU
AUTO EXTING
TEST
RESET
1 FADEC GND PWR 2
HYD
GREEN
BLUE
YELLOW
3000
PSI
3000
PSI
3000
PTU
RAT
ELEC
1
ELEC
2
A/SKID &
N/W STRG
ON
OFF

GENERAL

• Constant-speed gas turbine engine

•APU installed in tail cone

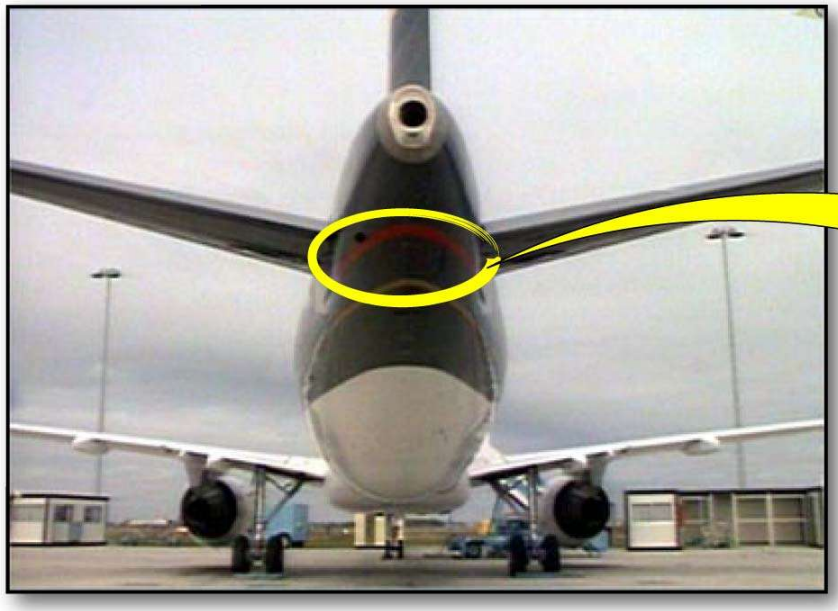
The Auxiliary Power Unit (APU) is a constant-speed gas turbine engine installed in the tail cone. The APU is a self-contained unit. With the APU, the A/C is independent of external pneumatic and electrical power sources.

• APU operates at all flight levels

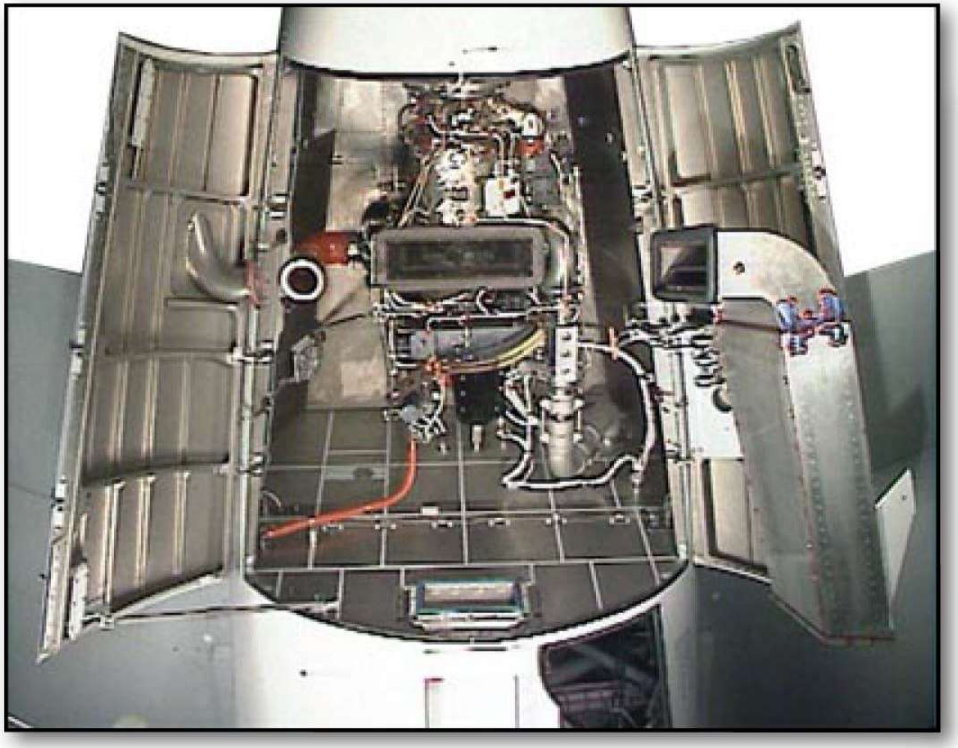
•Bleed air is not available above FL225 / FL200

The APU is designed to operate during all the flight envelope.

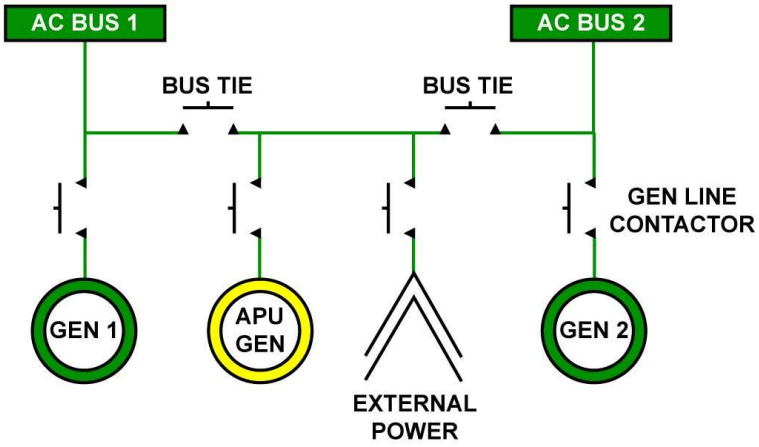
Electrical power is available while the APU operates, but if a back-up bleed source is necessary in flight, APU bleed air is available until a maximum altitude of FL200 for the APIC 3200 and FL225 for the Honeywell 131-9.



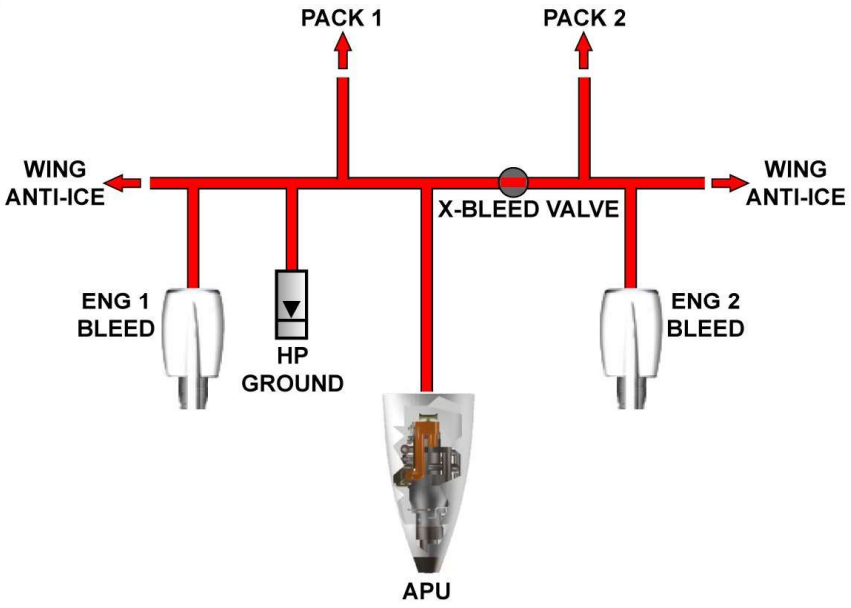
APU



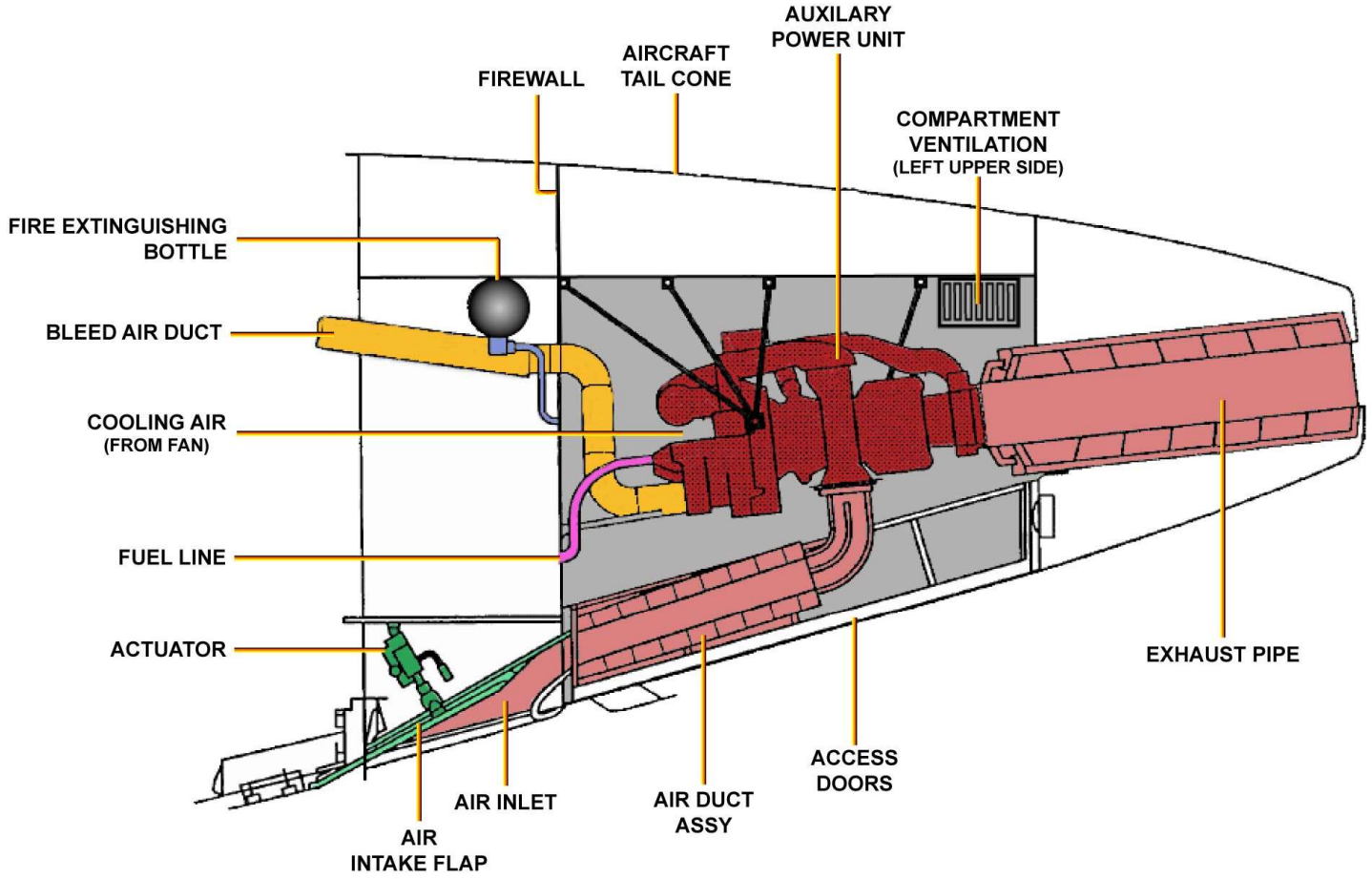
•APU supplies electrical and pneumatic power
The APU can supply:
- Electrical power for the A/C systems,
- Bleed air for engine starting and air conditioning on the ground,
- Bleed air for air conditioning/pressurization in flight.



The APU supplies electrical power and bleed air on the ground and in flight



•APU installation
The APU is installed in its compartment in the tail cone.
The Air Intake Flap and Duct assembly let air flow to the APU air inlet plenum.
Different components (the APU Bleed duct, the APU Generator output feeder cable, the APU fuel supply manifold, etc.) go through the front firewall.
The Air Intake Flap actuator operates the air intake flap and lets air go into the plenum.
The hot gases from the power section and unused APU bleed air are released through the Exhaust pipe.



ENGINE DESCRIPTION - HONEYWELL

• Constant speed

•Shaft power for the APU generator and for the Load compressor

The APU is a constant speed, single-shaft gas turbine engine that supplies mechanical shaft power to operate an accessory gearbox and a load compressor. The gearbox drives the APU generator.

The Load Control Valve supplies pneumatic power to start the air conditioning. A Surge Control Valve also gives protection to the load compressor against insufficient flow.

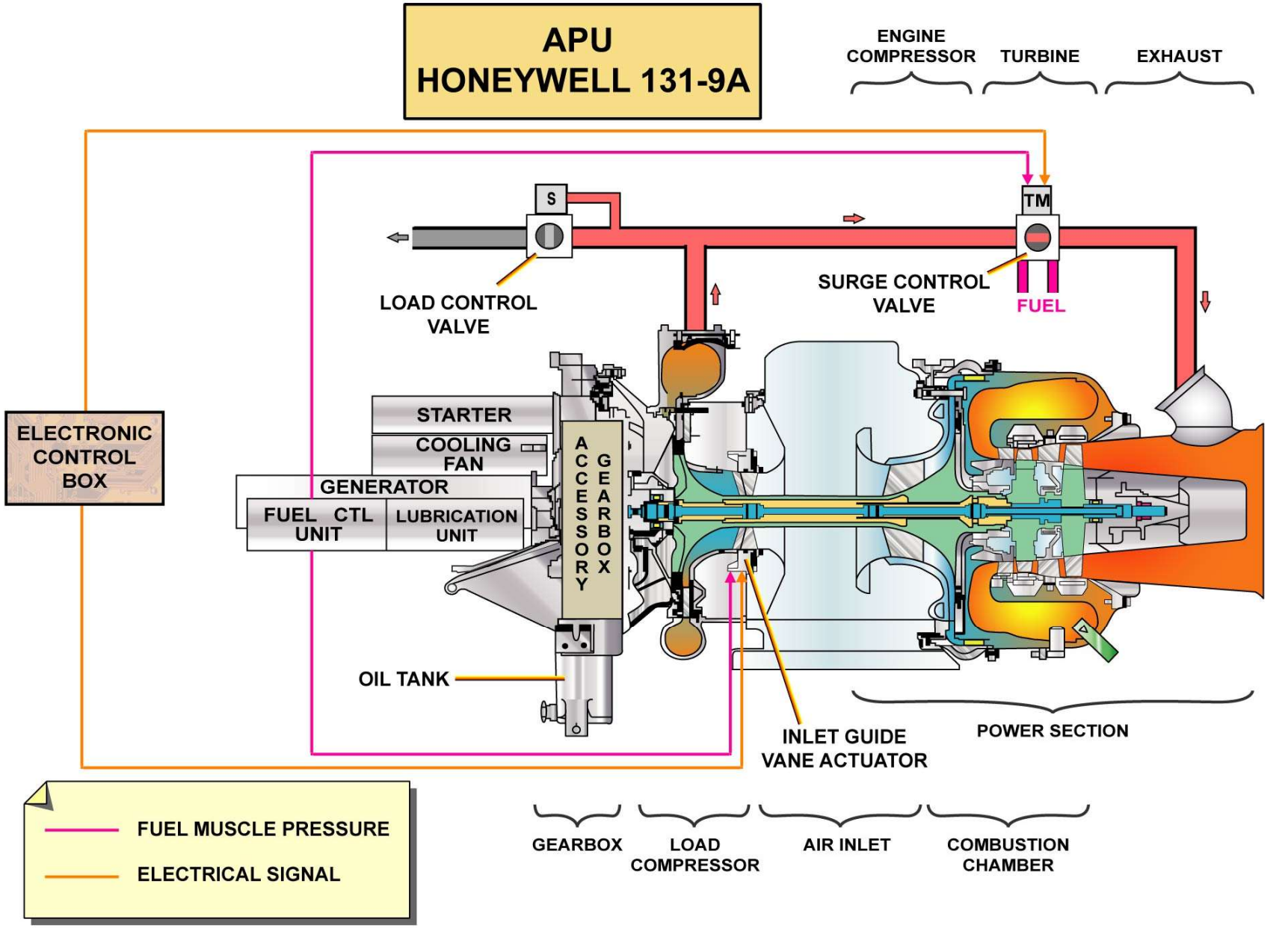
• ECB controls and monitors APU operation

The APU operation is controlled and monitored by the Electronic Control Box (ECB). The ECB has full authority over the following APU functions:

- Starting,
- Acceleration,
- Speed governing,
- Indication,
- Fault monitoring,
- Interface with A/C systems.

• ECB initiates auto shutdowns

The APU is capable of unattended operation; therefore, the ECB automatically shuts down the APU in case of a FAULT to protect the APU.


APU
HONEYWELL 131-9A
ENGINE
COMPRESSOR
TURBINE
EXHAUST
S
TM
LOAD CONTROL
VALVE
SURGE CONTROL
VALVE
FUEL
ELECTRONIC
CONTROL
BOX
STARTER
COOLING
FAN
GENERATOR
FUEL CTL
UNIT
LUBRICATION
UNIT
ACCESSORY
GEARBOX
OIL TANK
INLET GUIDE
VANE ACTUATOR
POWER SECTION
FUEL MUSCLE PRESSURE
ELECTRICAL SIGNAL
GEARBOX
LOAD
COMPRESSOR
AIR INLET
COMBUSTION
CHAMBER

ENGINE DESCRIPTION - APIC

• Constant speed

•Shaft power for the APU generator and for the Load compressor

The APU is a constant speed, single-shaft gas turbine engine that delivers mechanical shaft power to drive an accessory gearbox and a load compressor. The APU generator is driven by the gearbox.

The Bleed Control valve provides the pneumatic power for starting, air conditioning and it integrates the protective Surge Control function required to protect the load compressor against insufficient flow.

• ECB controls and monitors APU operation

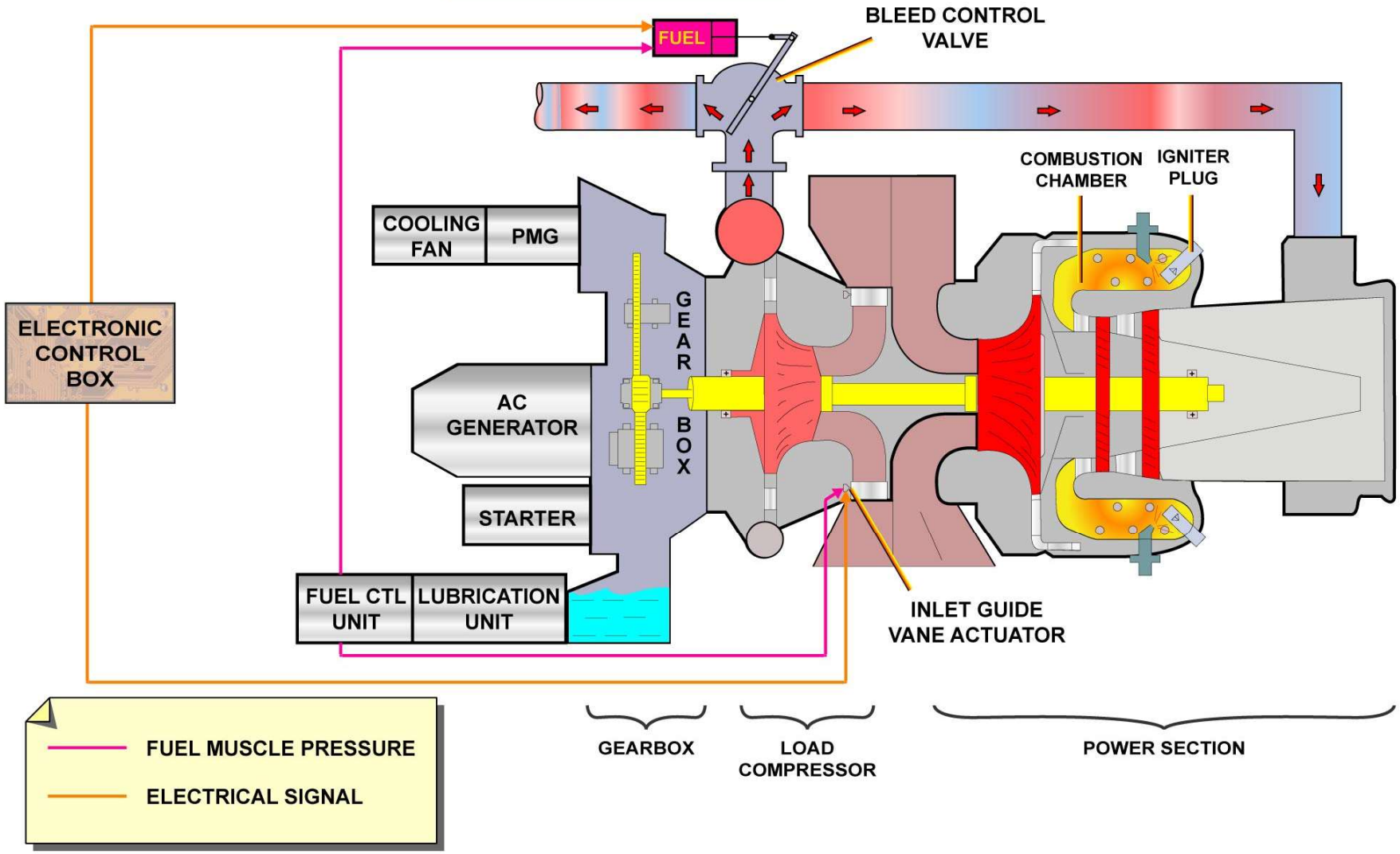
The APU operation is controlled and monitored by the Electronic Control Box (ECB). The ECB has full authority over the following APU functions:

- Starting,
- Acceleration,
- Speed governing,
- Indication,
- Fault monitoring,
- Interface with A/C systems.

• ECB initiates auto shutdowns

The APU is capable of unattended operation; therefore, the ECB automatically shuts down the APU in case of a FAULT to protect the APU.

APU APIC APS 3200



CONTROL AND INDICATING

• Control panels and Indications

This section will highlight the control panels and indications for the APU.

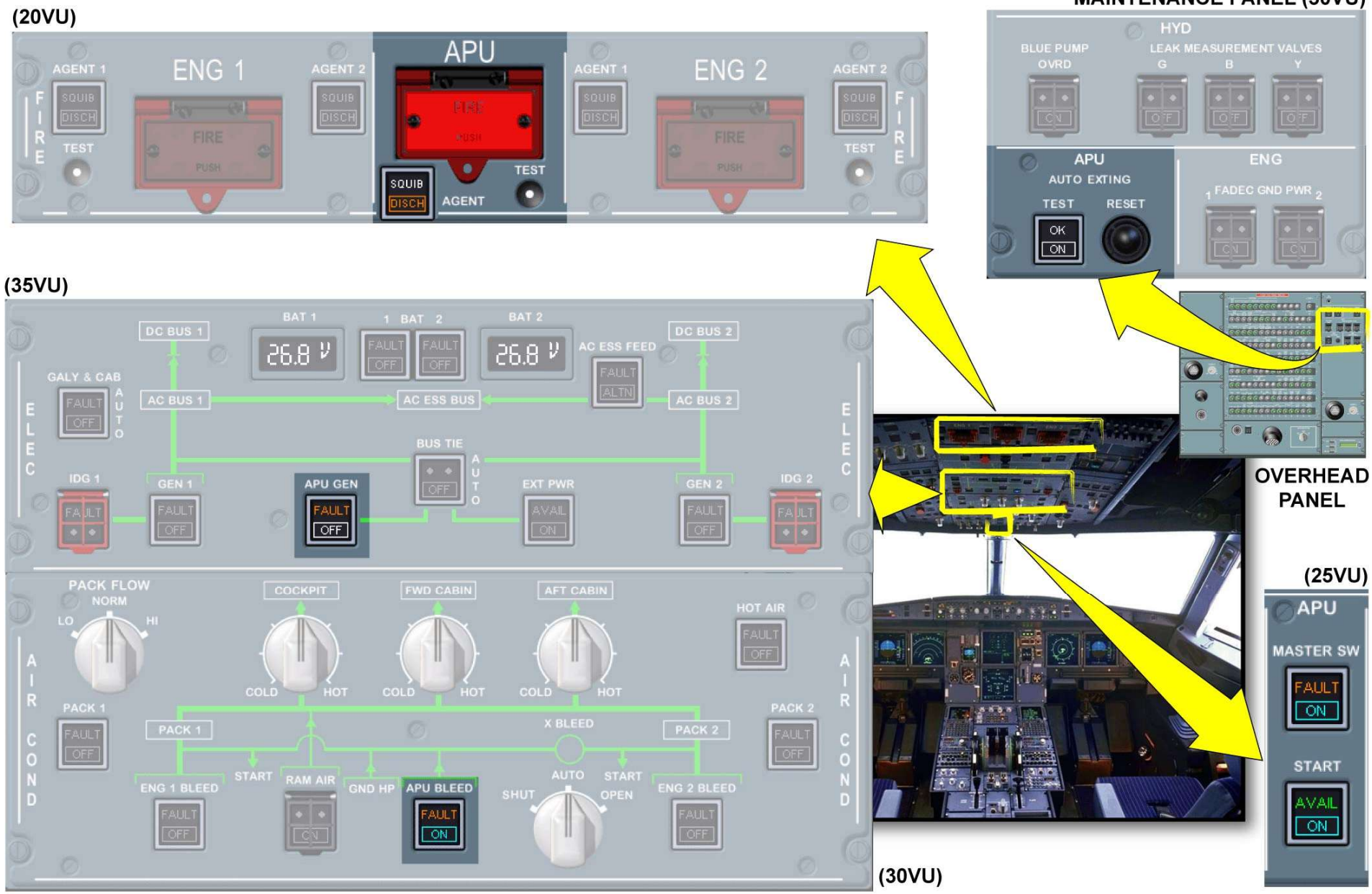
CONTROL PANELS

• APU operated using:

- APU MASTER SW and START P/BSW
- APU fire controls

The controls used to operate the APU are:

- The APU MASTER SWitch and START P/BSW, on the APU control panel,
- The APU fire controls, on the FIRE panel,
- Additionally, P/BSWs to deliver the electrical or pneumatic power, and to test the APU auto extinguishing circuits.

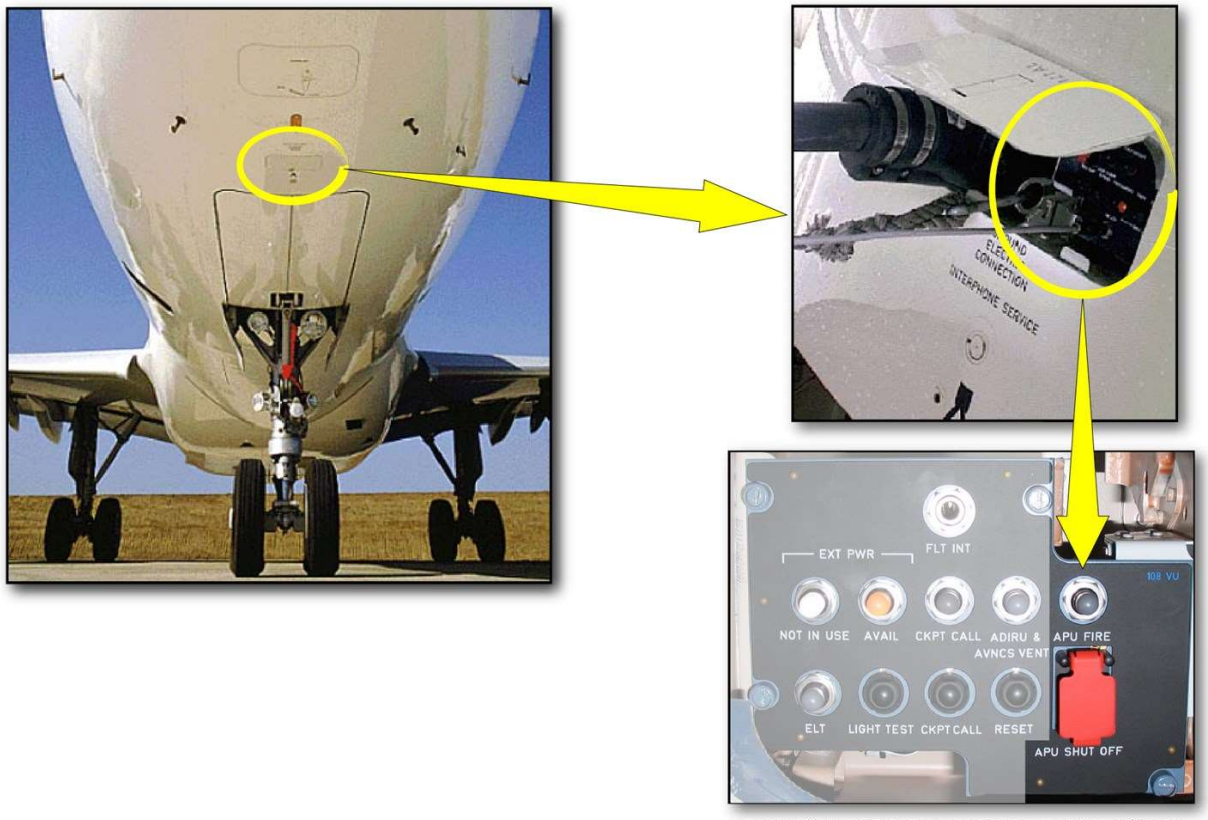

(20VU)
AGENT 1
ENG 1
AGENT 2
APU
AGENT 1
ENG 2
AGENT 2
FIRE
SQUIB
DISCH
TEST
PUSH
AGENT
MAINTENANCE PANEL (50VU)
HYD
BLUE PUMP
OVRD
LEAK MEASUREMENT VALVES
G
B
Y
APU
AUTO EXTING
TEST
RESET
OK
ON
ENG
FADEC GND PWR
(35VU)
DC BUS 1
BAT 1
BAT 2
DC BUS 2
AC ESS FEED
GALY & CAB
AC BUS 1
AC ESS BUS
AC BUS 2
BUS TIE
IDG 1
GEN 1
APU GEN
EXT PWR
GEN 2
IDG 2
ELEC
PACK FLOW
NORM
LO
HI
COCKPIT
FWD CABIN
AFT CABIN
HOT AIR
COLD
HOT
PACK 1
PACK 2
X BLEED
ENG 1 BLEED
START
RAM AIR
GND HP
APU BLEED
AUTO
SHUT
OPEN
ENG 2 BLEED
AIR COND
OVERHEAD PANEL
(25VU)
APU
MASTER SW
START
AVAIL
(30VU)

EXTERNAL CONTROLS

• External power control panel:

- APU FIRE
- Emergency shut down

If an APU FIRE warning occurs on the ground, a loud horn will be heard in the nose wheel well to alert ground personnel. A red APU FIRE light will also come on, on the external power control panel on the lower fuselage. It is possible to do an EMERGENCY shutdown of the APU from this panel. To do this, lift the guard and push the APU SHUT OFF P/BSW



EXTERNAL POWER CONTROL PANEL (108VU)

ECAM APU PAGE

•Parameters monitored on the APU page

APU parameters are displayed on the ECAM APU page. The APU generator parameters are duplicated on the ECAM ELEC page and the APU pneumatic parameters are duplicated on the ECAM BLEED page.

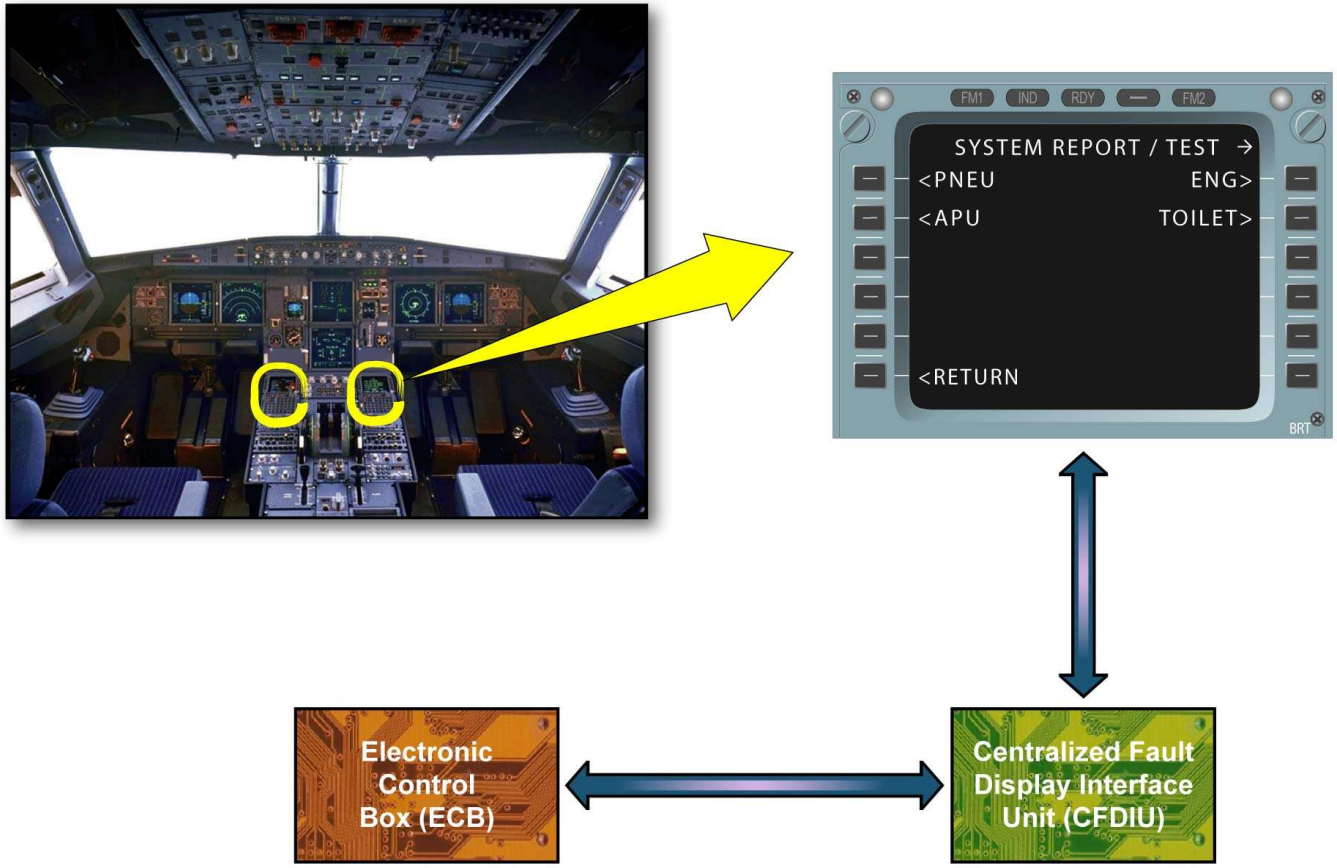
SYSTEM DISPLAY (SD)

MAINTENANCE/TEST FACILITIES

• CFDS fault messages of the APU system accessible through the MCDU

•BITE test available

Using the MCDU, you can have access to the Centralized Fault Display System (CFDS) fault messages of the APU system. Specific Built-In Test Equipment (BITE) tests are available as well.



SAFETY PRECAUTIONS

• Safety procedures for injury prevention

When you work on A/C, make sure that you obey all the Aircraft Maintenance Manual (AMM) safety procedures. This will prevent injury to persons and/or damage to the A/C. Here is an overview of main safety precautions related to the APU.

• Personal protection

Make sure that you use the correct personal protection when you work on the APU, as fuel and oil are poisonous.

• Do not touch the APU until it is sufficiently cool

Do not touch the APU until it is sufficiently cool.

• Extra fire fighting equipment when operating APU with access doors open

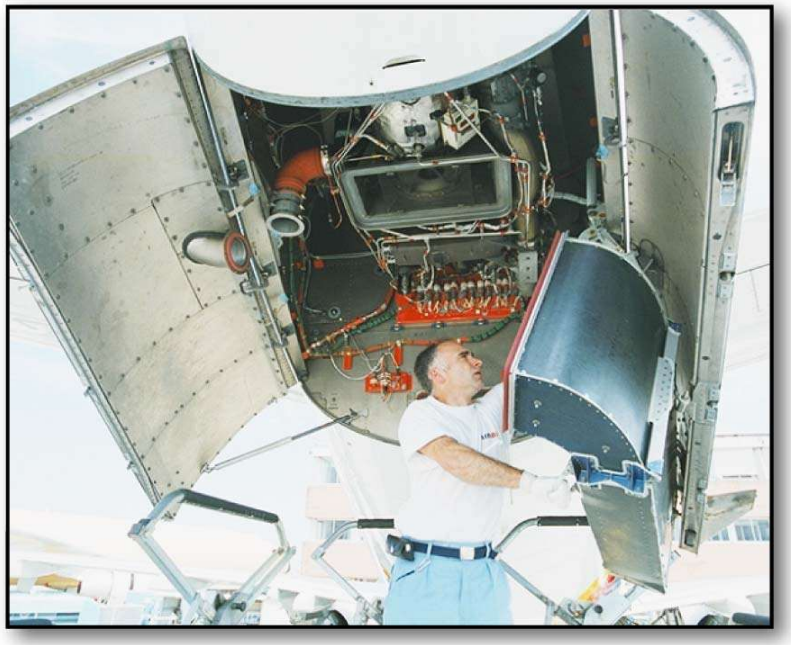
If you operate the APU with the APU access doors open or removed, make sure that you have the correct fire fighting equipment available. The onboard APU fire extinguishing system is not sufficient when these doors are not closed.

WARNING

OBEY ALL THE AMM SAFETY PROCEDURES

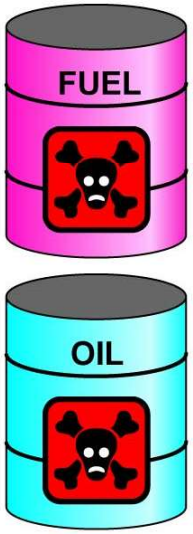
WARNING

DO NOT TOUCH THE APU UNTIL IT IS SUFFICIENTLY COOL



WARNING

USE THE CORRECT PERSONAL PROTECTION



WARNING

WHEN OPERATING THE APU WITH APU ACCESS DOORS OPEN, MAKE SURE THAT CORRECT FIRE EXTINGUISHING EQUIPMENT IS AVAILABLE

Auxiliary Power Unit System Component Location

SYSTEM OVERVIEW

Comp loc APU Compartment APU
Comp loc EXT rear Air Intake FLAP
Comp loc THS Compartment
FLAP actuator

• Constant-speed gas turbine engine
•APU is located in the tail cone

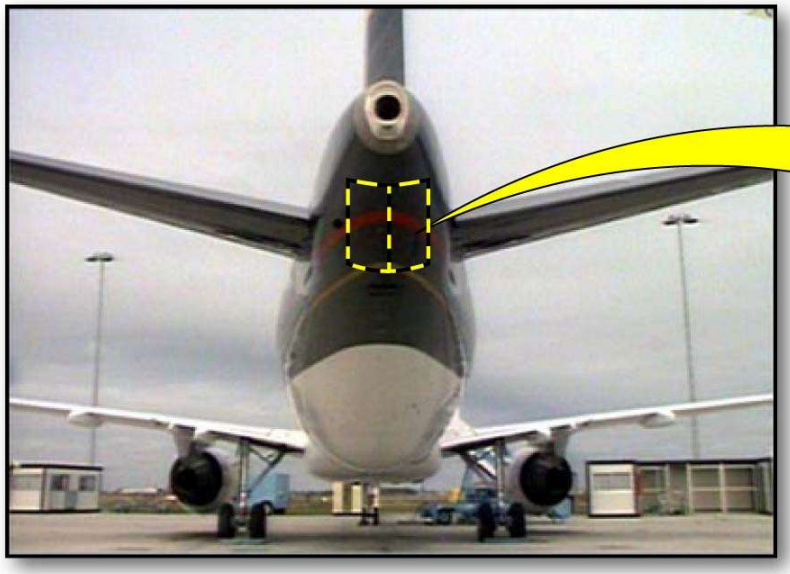
The Auxiliary Power Unit (APU) is a constant speed gas turbine engine. It is located in the unpressurized tail cone. The APU is a self-contained unit, which enables the aircraft to be independent of external pneumatic and electrical power sources.

•APU provides electrical and pneumatic power

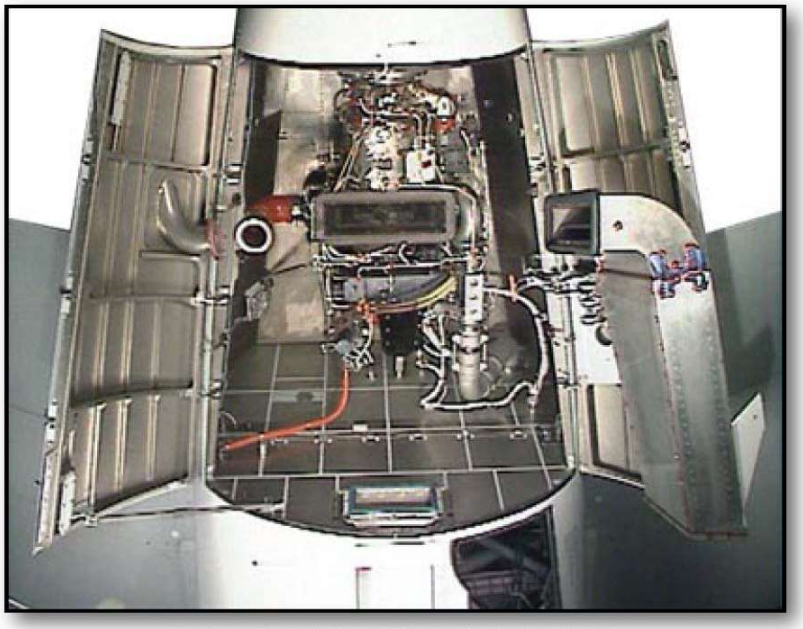
The constant-speed gas turbine engine drives the accessory gearbox and a load compressor. The APU provides:
- electrical power for the aircraft systems,
- bleed air for engine starting (MES), air conditioning (ECS) and wing anti ice testing on ground (not GTCP 36-300),
- bleed air for air conditioning and pressurization in flight until the specified manufacturer limit.

• APU runs at all flight levels
•Bleed cut off above 20,000 ft (APS3200, GTCP 36-300) or 22,500 ft (131-9A)

The APU is designed to operate throughout the entire flight envelope. Electrical power is available whenever the APU operates, but bleed air is shut off above the specified manufacturer limit.



AIRCRAFT TAIL CONE



AUXILIARY POWER UNIT (APU)

COMPONENT LOCATION

• APU in tail section

The APU is installed in the tail section of the fuselage.

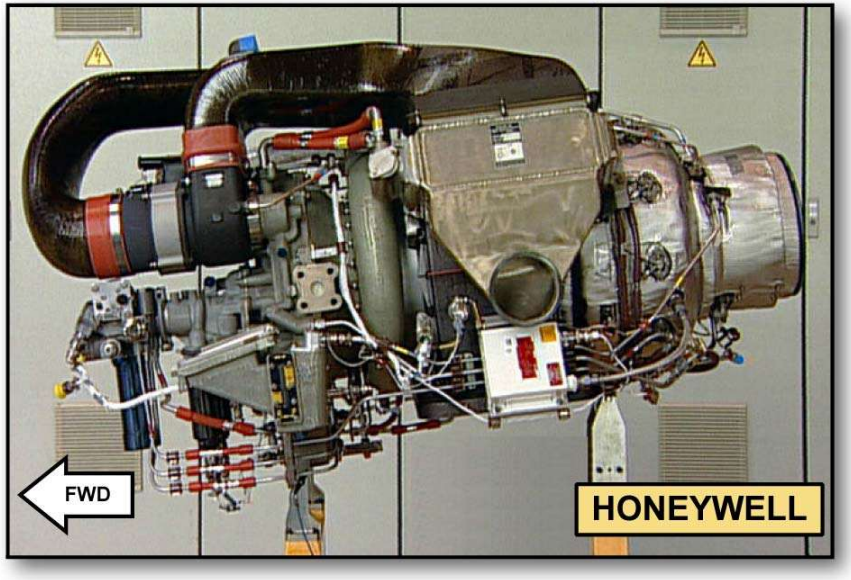
ENGINE VIEW

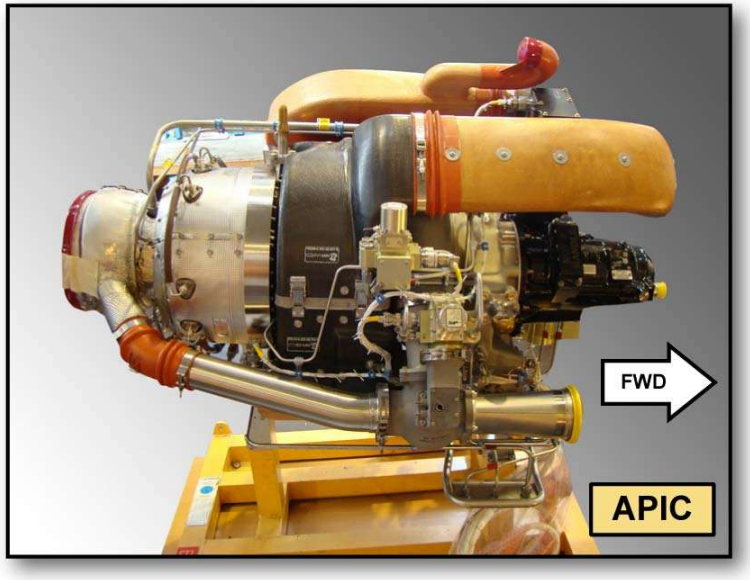
• APIC APU

The left and right hand sides of the APIC 3200 APU are shown.

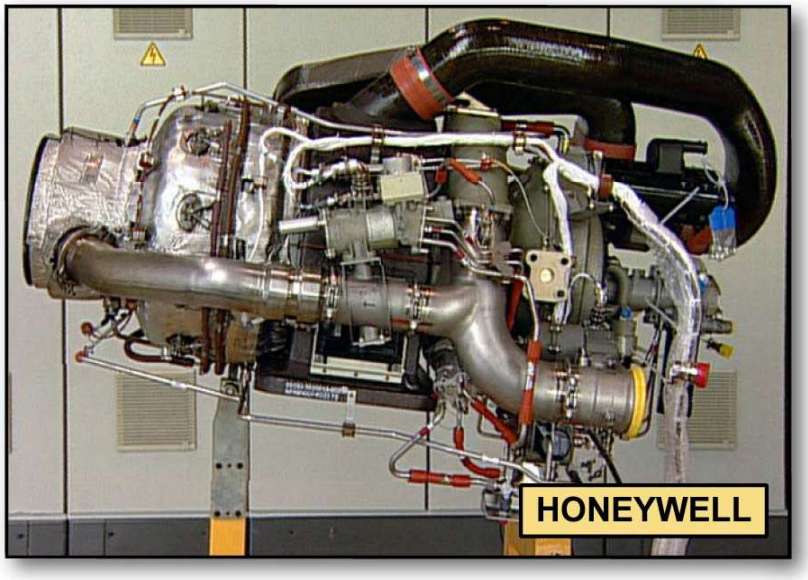
• HONEYWELL APU

The left and right hand sides of the Honeywell 131-9 [A] APU are shown.


FWD
HONEYWELL


FWD
APIC

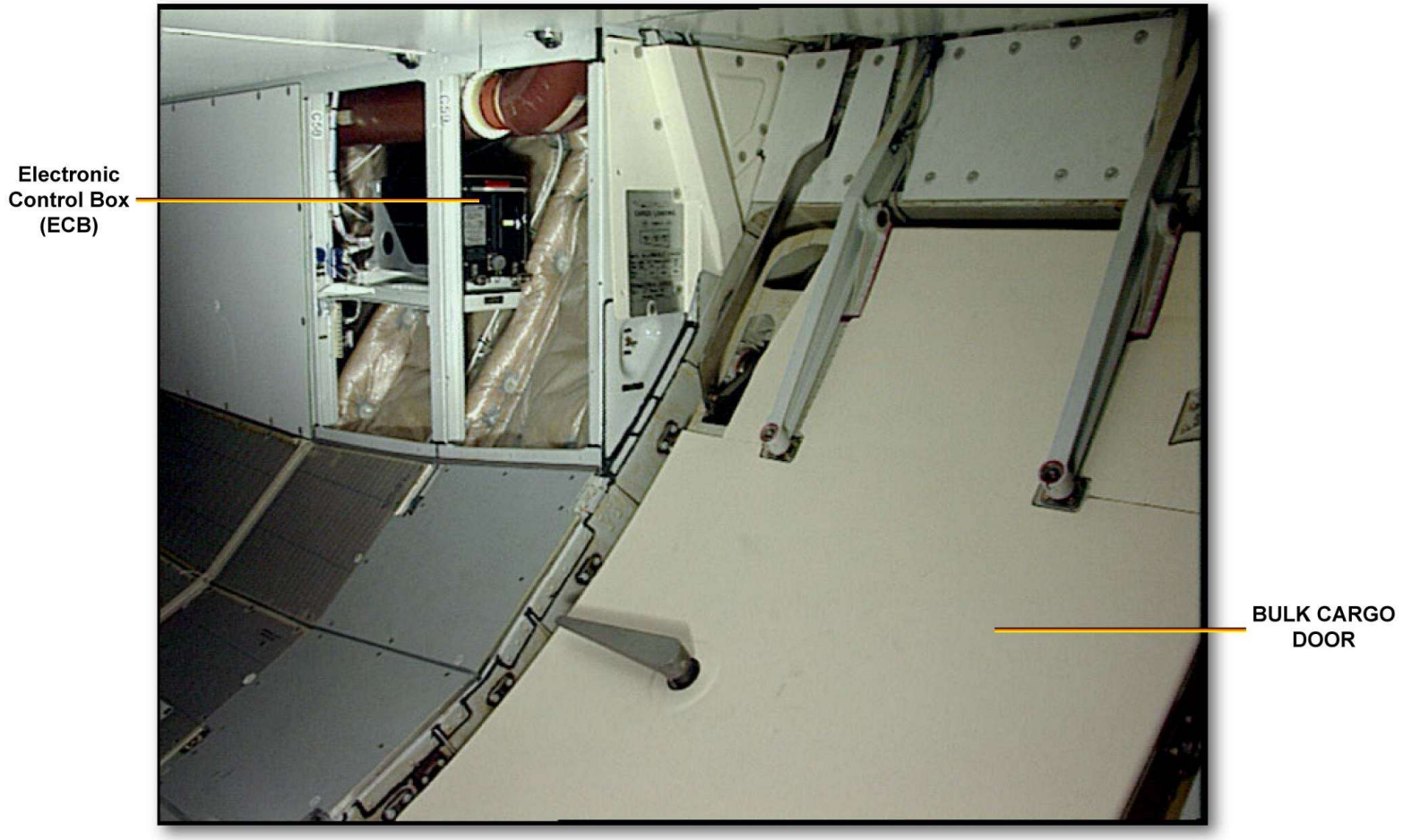

APIC


HONEYWELL

ELECTRONIC CONTROL BOX (ECB)

•Located in the aft cargo compartment RH side

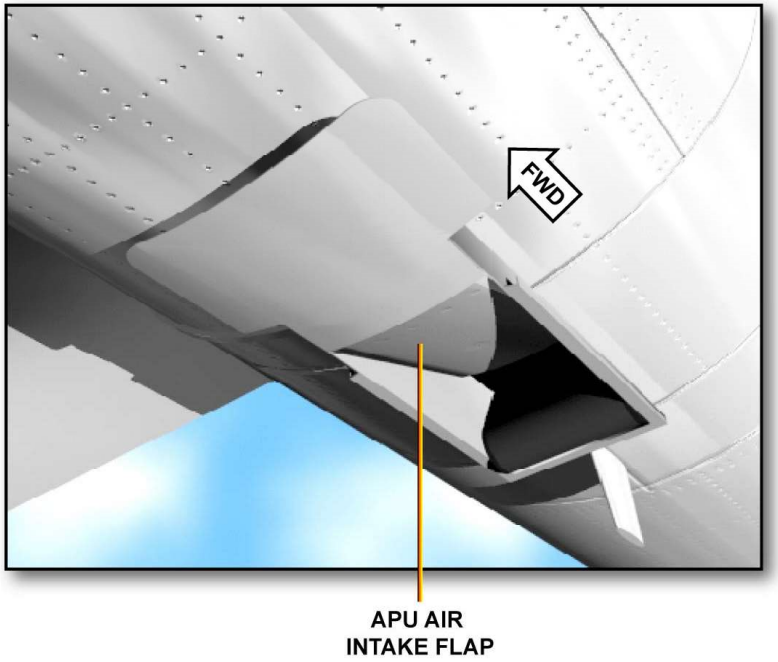
The ECB is in the aft cargo compartment, RH side.

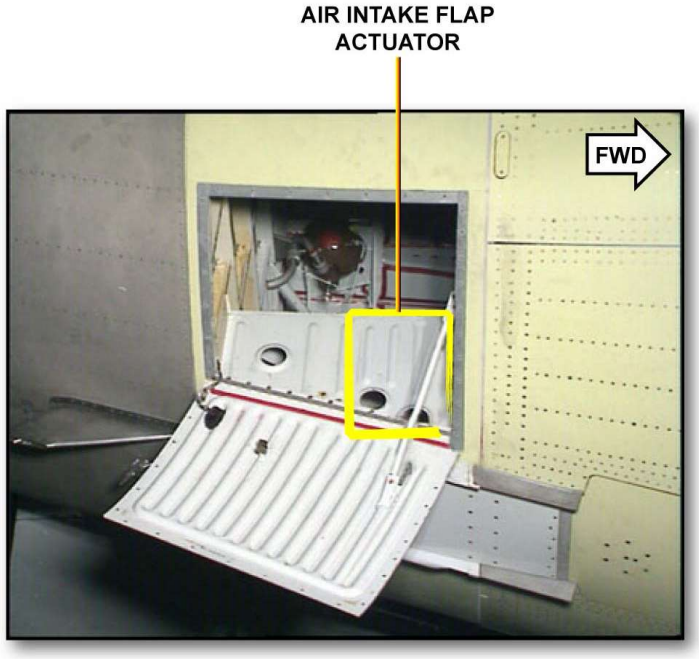


AIR INTAKE FLAP

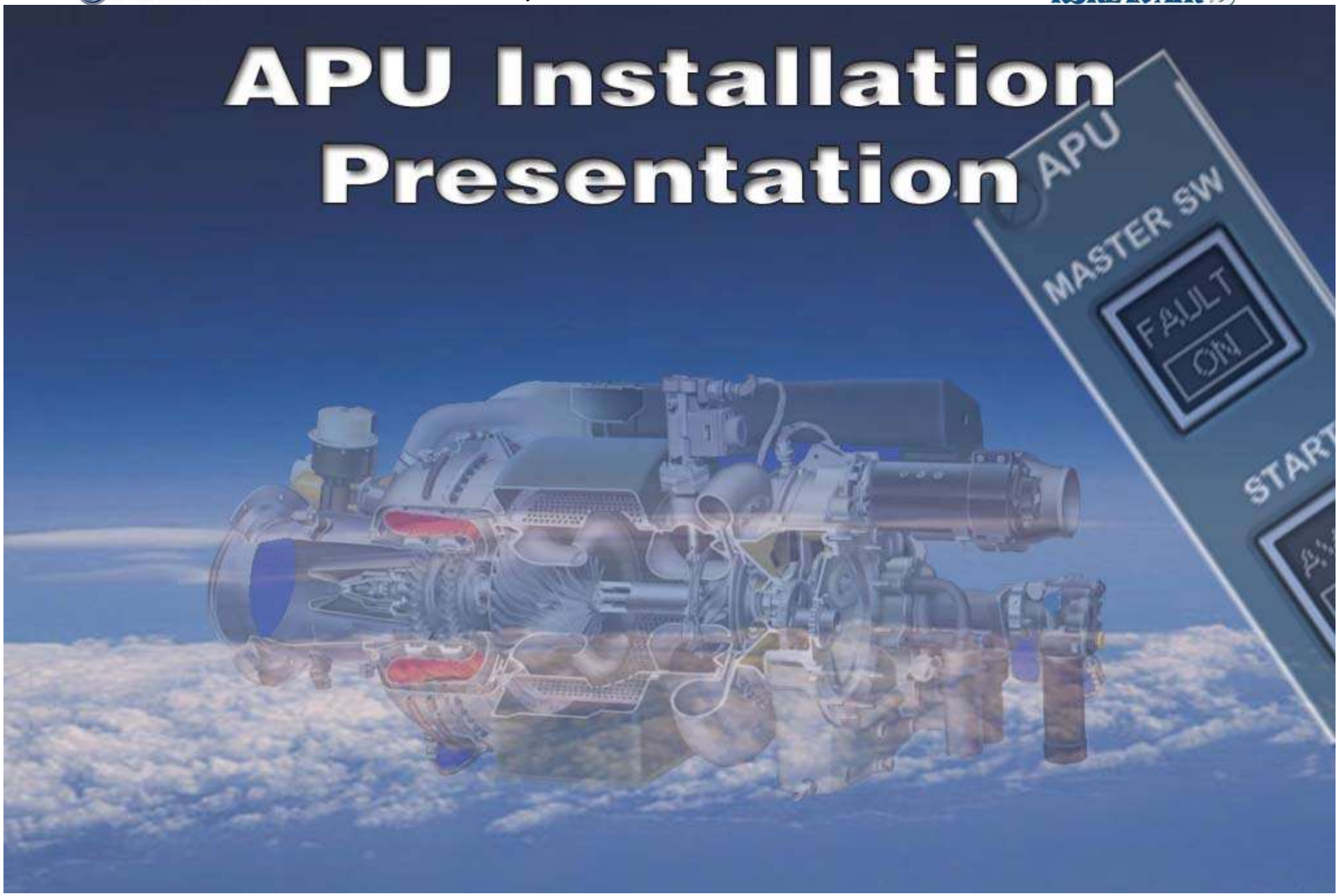
• Air supplied to the APU through the air intake flap:
    • Intake controlled by APU Master SW

The APU has an air intake flap. The air intake flap opens when the APU MASTER SWitch is set to ON and it closes when the MASTER SWitch is set to OFF and the APU stops. When open, it supplies air to the APU inlet for combustion and pneumatic supply.





APU Installation Presentation



GENERAL

• Fireproof COMPT

The Auxiliary Power Unit (APU) is installed in a fireproof COMParTment (COMPT) located in the fuselage tail cone.

MOUNTS

• Seven tie rods

•Three-point mounted suspension system

•Three insulators

Seven tie rods attach the APU to the structure brackets on the APU COMPT ceiling. These tie rods also connect to the APU three-point mounted suspension system. Vibration isolators are installed between the APU mount brackets and the tie rods to reduce the transmission of A/C vibrations and shocks to the APU. The isolators also prevent the transmission of vibrations from the APU to the A/C structure.

AIR INTAKE FLAP

• Air to plenum chamber

•Closed when APU shut-down

•Closed and opened manually with manual override device

The air intake system ducts ambient air to the APU plenum chamber. An air intake flap cuts off the air supply when the APU does not operate. In case of failure, the air intake flap can be opened or closed manually by a manual override device.

AIR INTAKE DUCT

• Attached to the right access door

The air intake duct, which is composed of a diffuser and elbow, provides correct airflow to the APU plenum. The air intake duct is attached to the right access door.

EXHAUST

• Gas flows into atmosphere, noise muffled

•A/C structure protected by muffler thermal insulation

The exhaust system lets the APU exhaust gas flow into the atmosphere and muffles the noise from the exhaust. The exhaust muffler thermal insulation protects the A/C structure.

ACCESS DOORS

• Two access doors open outwards

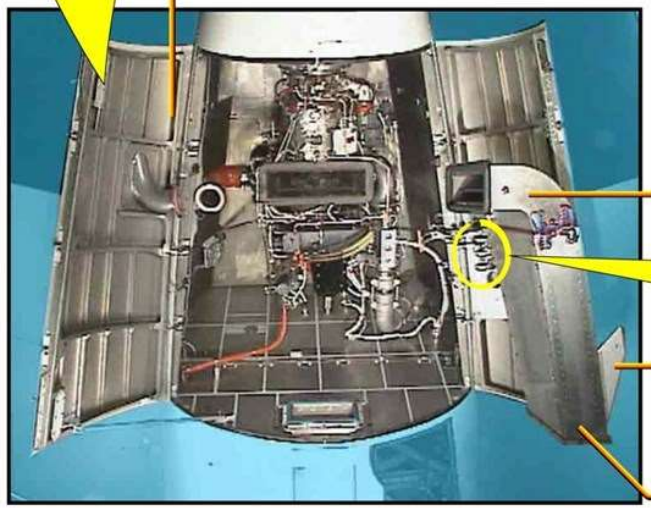
Two access doors allow access to the APU COMPT. The access doors on the bottom of the tail cone open outwards to allow the APU to be inspected, lifted and lowered.

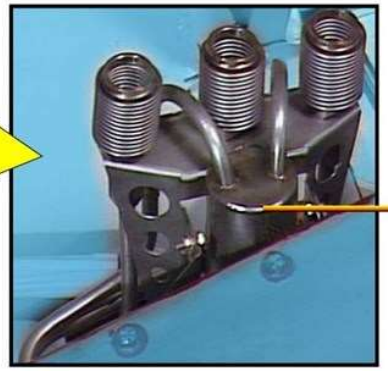
DRAIN SYSTEM

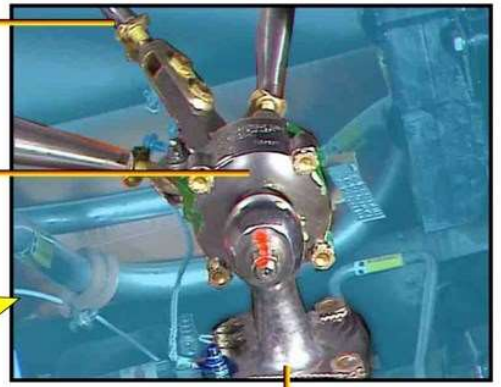
• Drain tank

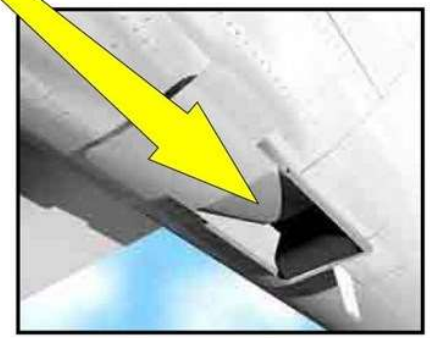
•Drain mast, operation when velocity above 200 kt

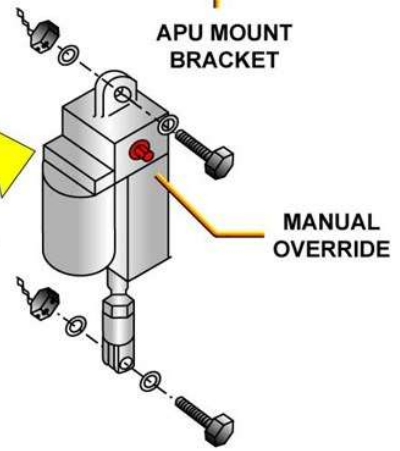
A drain system prevents the collection of fluids in the APU COMPT. Any fluid that may accumulate in the APU COMPT is delivered to a drain mast. Some of the fluids are collected in a drain tank in the APU COMPT, which is emptied through the drain mast when the A/C is above 200 kt.

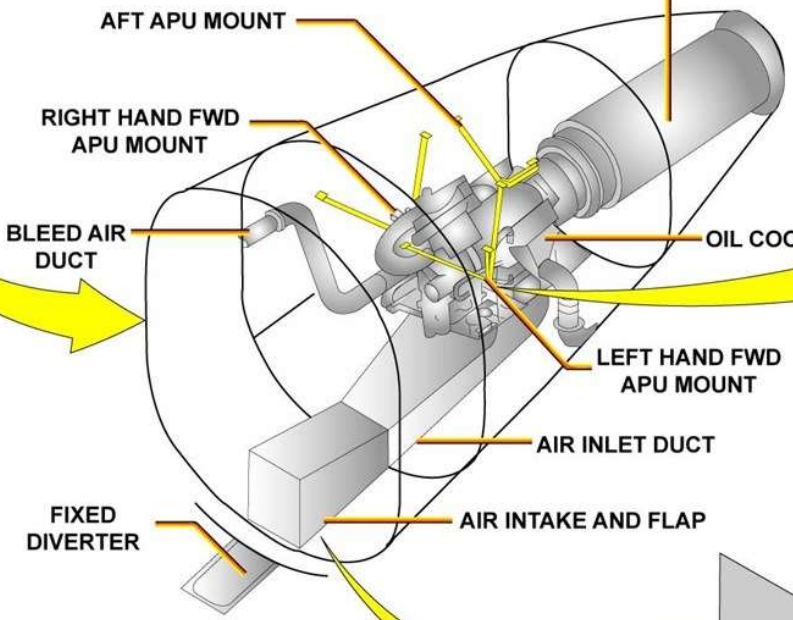












EXHAUST MUFFLER
AFT APU MOUNT
RIGHT HAND FWD APU MOUNT
BLEED AIR DUCT
OIL COOLER
LEFT HAND FWD APU MOUNT
AIR INLET DUCT
FIXED DIVERTER
AIR INTAKE AND FLAP
SUSPENSION RODS
VIBRATION ISOLATOR
APU MOUNT BRACKET
ACTUATOR
MANUAL OVERRIDE
ACCESS DOOR
ELBOW
DRAIN MAST
DIFFUSER
DRAIN TANK

APU Drain System Presentation

Apu Drain System

• Collection of fluids in the APU system and compartment

A drain system prevents the collection of fluids in the Auxiliary Power Unit (APU) system and compartment.

FUEL CONTROL UNIT/OIL PUMP SEAL DRAIN

• Routed via a collector line

The fuel and oil pump seal drain line is routed via a collector line to the drain tank. This line drains fuel or oil leaks.

INLET GUIDE VANE ACTUATOR DRAIN

• Collector line to the drain tank

The Inlet Guide Vane (IGV) actuator drain line is routed via the collector line to the drain tank. This line drains only fuel leaks.

GEARBOX VENT

• Oil reservoir with air/oil separator

•Gear driven air/oil separator

•Vent line to the APU exhaust cone

The oil reservoir has a connection to the ambient air through an air/oil separator. The gear driven air/oil separator is connected through a gearbox vent line to the APU exhaust cone.

SURGE CONTROL VALVE DRAIN

• Drain tank, FCU/IGV actuator common drain line

The surge control valve fuel is drained into the drain tank by the Fuel Control Unit (FCU)/IGV actuator common drain line.

LOAD COMPRESSOR CAVITY DRAIN

• Prevent any ingestion of oil

•Compressor bearing cavities are kept dry by buffering air

•Oil drained to the drain mast

To prevent any ingestion of oil in the bleed system the load compressor bearing cavities are kept dry by buffering air into the main shaft seals. An oil leak witness drain is located aft of the seal to collect any oil leakage. The oil is drained directly overboard through the drain mast.

TURBINE PLENUM DRAIN

• Drained fuel in the combustor plenum to the drain mast

A turbine plenum drain orifice is provided to drain fuel that may accumulate in the combustor following an unsuccessful light-up. The fuel is drained directly overboard through the drain mast.

EXHAUST MUFFLER DRAIN

• Water or cleaning fluid drained to drain mast

The exhaust muffler drain line is routed to the drain mast. This drain line collects water or cleaning fluid.

APU COMPARTMENT DRAIN

• Water, cleaning agents, oil and fuel drained to the drain mast

Water coming from rain or condensate humidity, cleaning agents and any oil and fuel in the compartment, due to leaks or APU servicing, are drained to the lowest point of the APU door and through the drain mast overboard.

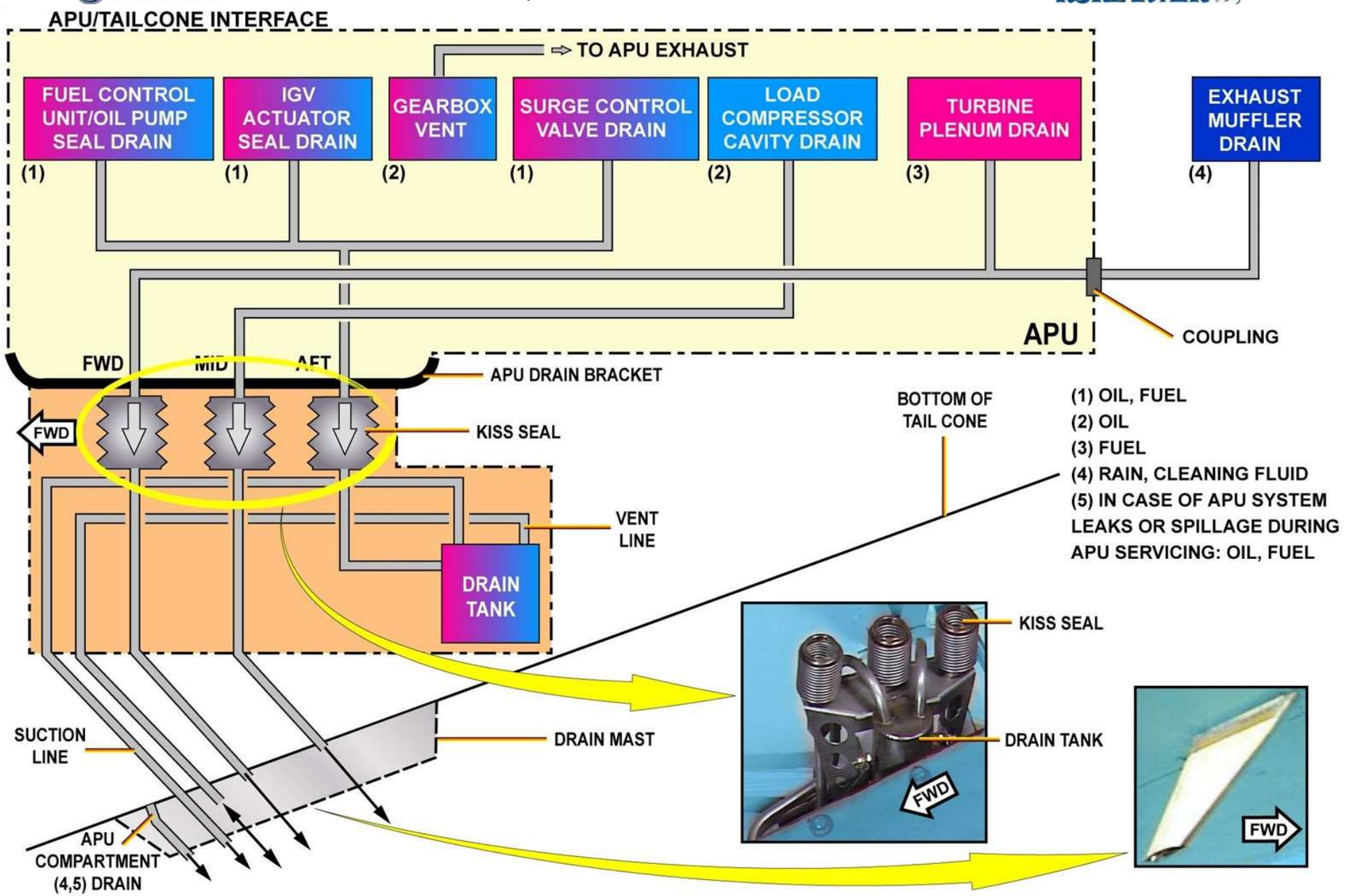
DRAIN TANK

• Drain tank is connected to the drain mast

•Vacuum in the drain line, suction effect at 200 kts

•Drain lines connected to the right access door through kiss seals

For venting and evacuation, the drain tank is connected to the drain mast. Airflow across the drain mast creates a vacuum in the drain line. The suction effect produced at 200 kts, is sufficient to remove the contents of the drain tank. A vent line ventilates the drain tank and drain lines. The APU drain lines are connected to the right access door drain lines through spring adapter kiss seals.


APU/TAILCONE INTERFACE
TO APU EXHAUST
FUEL CONTROL UNIT/OIL PUMP SEAL DRAIN
(1)
IGV ACTUATOR SEAL DRAIN
(1)
GEARBOX VENT
(2)
SURGE CONTROL VALVE DRAIN
(1)
LOAD COMPRESSOR CAVITY DRAIN
(2)
TURBINE PLENUM DRAIN
(3)
EXHAUST MUFFLER DRAIN
(4)
APU
COUPLING
FWD
MID
AFT
APU DRAIN BRACKET
FWD
KISS SEAL
VENT LINE
DRAIN TANK
BOTTOM OF TAIL CONE
(1) OIL, FUEL
(2) OIL
(3) FUEL
(4) RAIN, CLEANING FLUID
(5) IN CASE OF APU SYSTEM LEAKS OR SPILLAGE DURING APU SERVICING: OIL, FUEL
KISS SEAL
DRAIN TANK
FWD
FWD
SUCTION LINE
DRAIN MAST
APU COMPARTMENT (4,5) DRAIN

APU Basic Description

GENERAL
• Three APU modules
The Auxiliary Power Unit (APU) is of a modular design. The three APU modules are:
- the power section,
- the load compressor,
- the accessory drive gearbox.

ENGINE COMPRESSOR
• Single stage compressor design
•Components
The compressor is of a single stage centrifugal compressor design. The main components of the compressor are:
- a single stage centrifugal impeller,
- single stage diffuser vanes,
- axial de-swirl vanes.

COMBUSTION CHAMBER
• Reverse flow annular design
•Components
The combustion chamber is of a reverse flow annular design and is installed inside the turbine plenum. The main parts of the combustion chamber are:
- the inner combustion chamber shell,
- the outer combustion chamber shell.

The following components are installed on the combustion chamber:
- an igniter plug,
- 10 dual orifice fuel nozzles.

TURBINE
• Turbine drives engine compressor, load compressor and AGB
•Two-stage axial flow
•Cooled and un cooled stage
•Annular exhaust diffuser
The turbine assembly drives the engine compressor, the load compressor and the gear train of the Accessory Gearbox (AGB). The two-stage axial flow turbine includes:
- a cooled first stage nozzle,
- inserted first stage rotor blades,
- an un cooled second stage stator,
- a dual alloy second stage rotor,
- an annular exhaust diffuser.

LOAD COMPRESSOR
• Single-stage centrifugal design
•Primary components
•Two bearings:
    - 1 duplex ball bearing in front of L/C impellor
    - 1 roller bearing aft of the 2nd stage turbine

The load compressor is of a single-stage centrifugal design. It supplies bleed air to the pneumatic system. The primary components of the load compressor are:
- the inlet guide vane assembly,
- the load compressor impeller,
- the load compressor diffuser,
- the load compressor scroll.

The shaft is held with two bearings: one duplex ball bearing in front of the load compressor impellor and one roller bearing aft of the second-stage turbine. As an option, the duplex ball bearing is made of ceramic to make the bearing more resistant to damage caused by debris that go into the bearing compartment.

INLET GUIDE VANES

• Control of bleed air flow and pressure from load compressor
•16 IGVs actuated by pressurized fuel
•Bleed demands
•MES, ECS

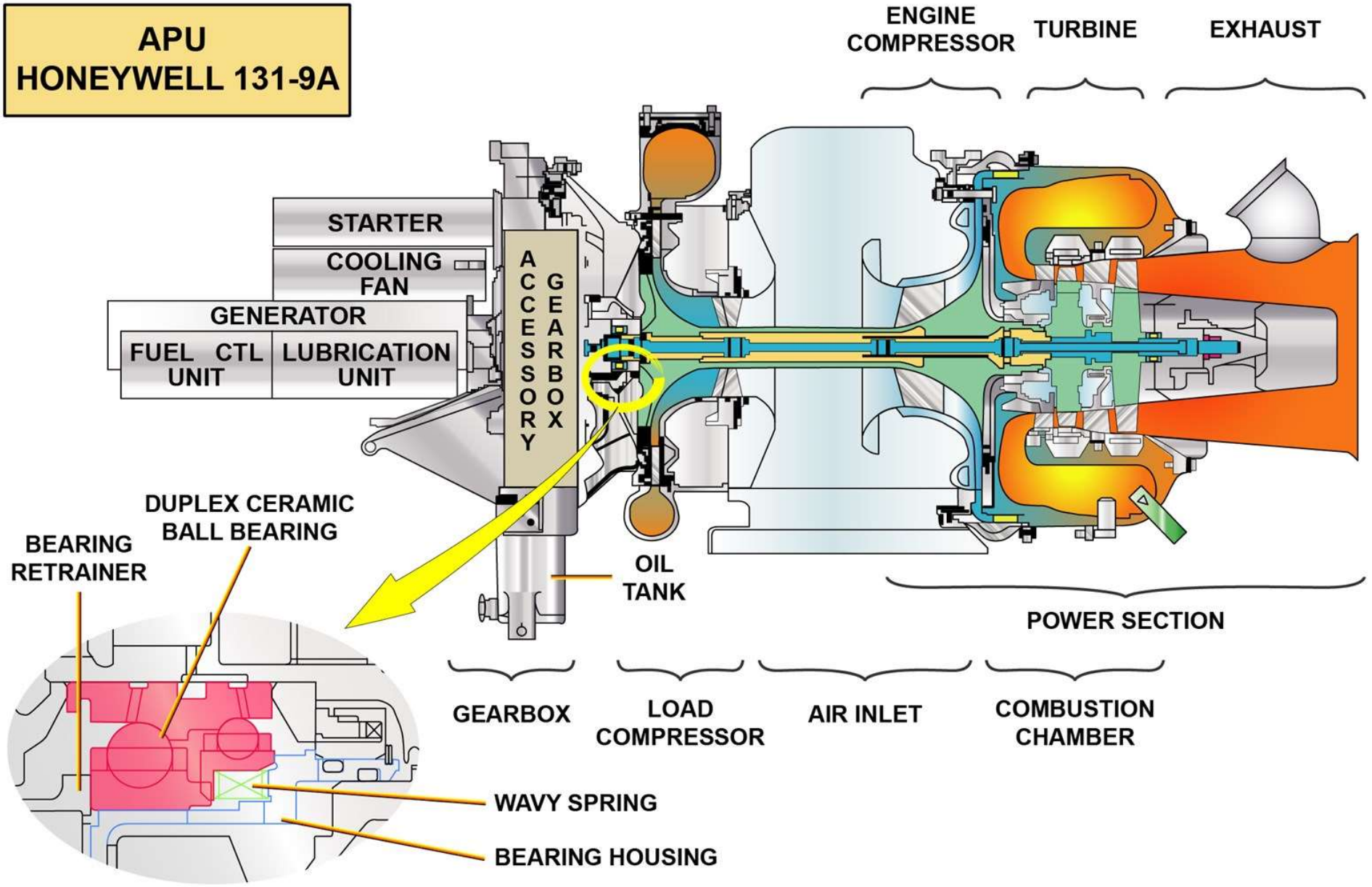
The Inlet Guide Vanes (IGVs) control the amount of bleed air flow and pressure from the APU load compressor. The 16 IGVs are moved simultaneously by a gear train operated by an actuator. The IGV actuator is operated by high-pressure fuel supplied from the Fuel Control Unit (FCU). The IGV opening angle depends on the bleed air demand for:
- Main Engine Start (MES) system,
- Environmental Control System (ECS).

ACCESSORY GEARBOX

• Shaft power transmission to accessories
•Oil reservoir
•Components

The gearbox transmits the shaft power to the APU accessories and to the APU generator, which are installed on the gearbox pads. The gearbox is also the oil reservoir for the APU lubrication system. The components mounted on the accessory gearbox are:
- the starter motor assembly,
- the cooling air fan assembly,
- the lubrication unit with the oil pump assembly which drives the FCU,
- the AC generator.

APU HONEYWELL 131-9A



APU
Ignition and Starting
Description and Operation

STARTER CONTROL

• Function

During starting, the electrical starter causes initial rotation of the Auxiliary Power Unit (APU) shaft when it drives the Accessory Gearbox (AGB). When the APU speed is around 50%, the Electronic Control Box (ECB) stops the electrical supply to the starter by opening the main start contactor.

The main start contactor 5KA and the backup start contactor 10KA are heavy duty contactors that switch electrical current to the starter motor. During Ram Air Turbine (RAT) extension, APU starting is inhibited by the Battery Charge Limiters (BCL 1 and BCL 2), which prevent operation of the main start contactor 5 KA by removing the necessary ground signal, to operate the Main Start Contactor, from the MASTER SW.

IGNITION CONTROL

•Function

The ignition system causes initial light-off of the fuel air mixture. The ignition system includes an ignition box that energizes an igniter plug. During starting, the ECB switches the ignition to ON between 0% and 60%. When the APU speed drops below 95% due to a flame-out, the ECB starts the ignition until the APU reaches again 100% of speed.

STARTER

FUEL INJECTOR NOZZLE

BCL 1

2

25VU

APU

MASTER SW

FAULT

ON

START

AVAIL

ON

MAIN START CONTACTOR (5KA)

BACK-UP START CONTACTOR (10KA)

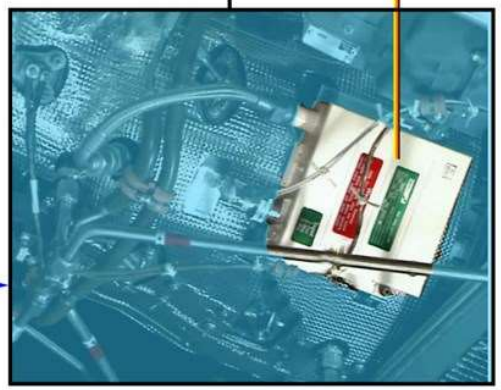
28 VDC BAT BUS

28 VDC BAT BUS

ECB

IGNITER

IGNITION BOX



APU Fuel System Description and Operation

GENERAL

• APU fuel system constitution:

- FCU
- Fuel schedule
- Muscle pressure
- Fuel shut-off
- Flow divider and solenoid valve
- Fuel supply
- Fuel drain
- Control
- Monitoring

The fuel system supplies metered fuel to sustain combustion. Part of the fuel, as muscle pressure, operates the Inlet Guide Vane (IGV) actuator and the surge control valve actuator. This system is made of:

- Fuel Control Unit (FCU),
- fuel schedule,
- muscle pressure,
- fuel shut-off,
- flow divider and solenoid valve,
- fuel supply,
- fuel drain,
- control,
- monitoring.

CONTROL

• During on-speed operation the ECB uses:

- APU speed
- EGT
- Aircraft demand signals

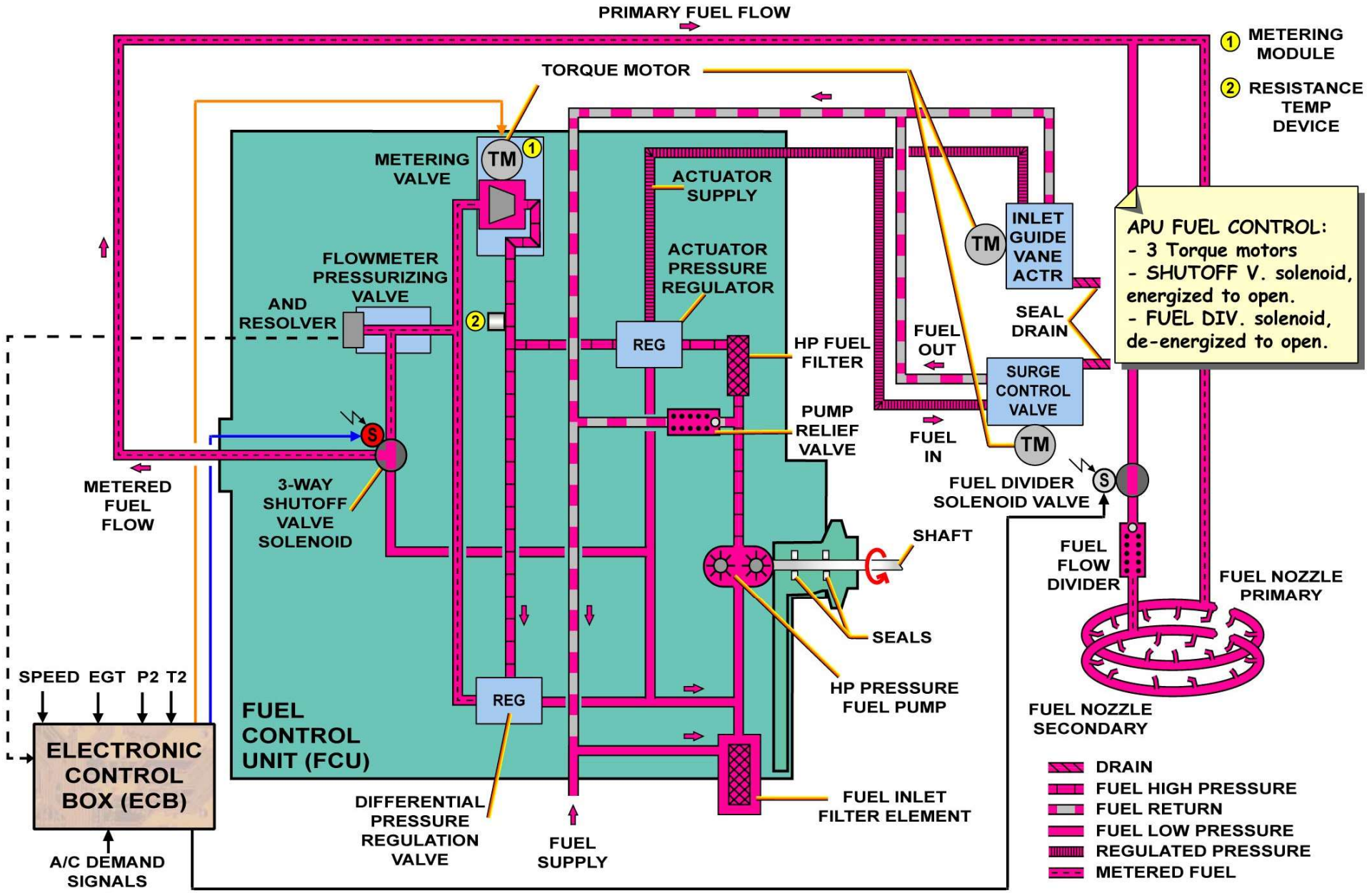
•During start it uses:

- Speed
- EGT
- Air inlet PRESS and TEMP SENSR

•ECB operates the:

- Fuel metering valve
- Flow divider solenoid
- 3-way shut-off solenoid valve

The ECB controls the fuel system with several parameters. During on-speed operation, the ECB uses APU speed, Exhaust Gas Temperature (EGT) and aircraft demand signals. During start, it uses speed, EGT, air inlet pressure and temperature sensors (P2 and T2). The ECB operates the fuel metering valve, the flow divider solenoid valve and the 3-way shut-off solenoid valve.


PRIMARY FUEL FLOW
TORQUE MOTOR
METERING VALVE
TM
1
ACTUATOR SUPPLY
ACTUATOR PRESSURE REGULATOR
FLOWMETER PRESSURIZING VALVE AND RESOLVER
2
REG
HP FUEL FILTER
PUMP RELIEF VALVE
INLET GUIDE VANE ACTR
SEAL DRAIN
FUEL OUT
SURGE CONTROL VALVE
FUEL IN
S
3-WAY SHUTOFF VALVE SOLENOID
METERED FUEL FLOW
FUEL DIVIDER SOLENOID VALVE
SHAFT
FUEL FLOW DIVIDER
FUEL NOZZLE PRIMARY
SEALS
HP PRESSURE FUEL PUMP
FUEL NOZZLE SECONDARY
SPEED EGT P2 T2
ELECTRONIC CONTROL BOX (ECB)
FUEL CONTROL UNIT (FCU)
DIFFERENTIAL PRESSURE REGULATION VALVE
FUEL SUPPLY
FUEL INLET FILTER ELEMENT
A/C DEMAND SIGNALS
1 METERING MODULE
2 RESISTANCE TEMP DEVICE
APU FUEL CONTROL:
- 3 Torque motors
- SHUTOFF V. solenoid, energized to open.
- FUEL DIV. solenoid, de-energized to open.
DRAIN
FUEL HIGH PRESSURE
FUEL RETURN
FUEL LOW PRESSURE
REGULATED PRESSURE
METERED FUEL

FUEL CONTROL UNIT

•Six functions:

- Fuel filtering
- Pressure increase
- Fuel metering
- Flow meter control
- Positive fuel shut-off
- Fuel muscle pressure regulation

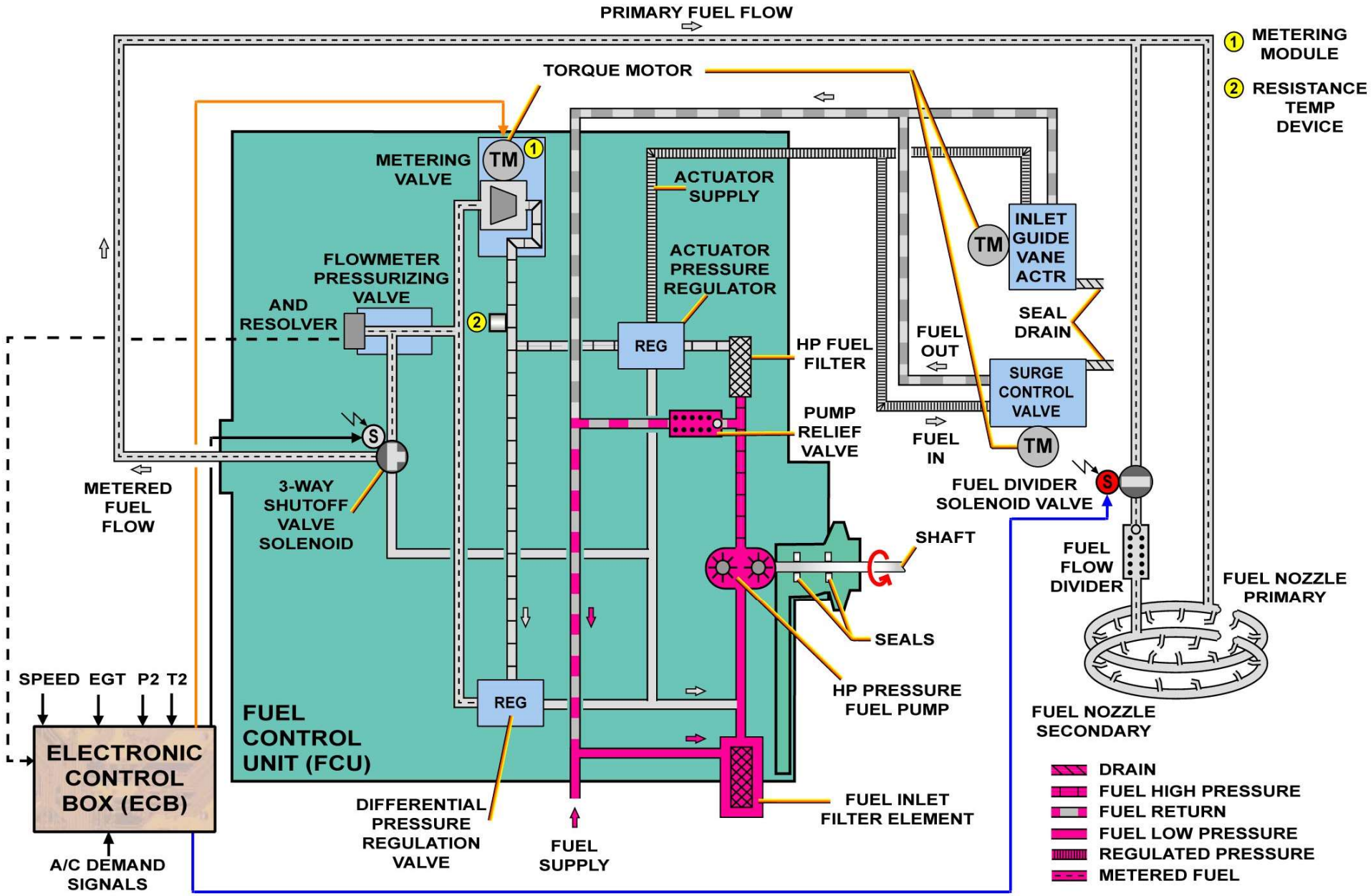
•Components

The FCU has six functions:
- fuel filtering,
- pressure increase,
- fuel metering,
- flow meter control,
- positive fuel shut-off,
- fuel muscle pressure regulation.

The FCU is made of a LP inlet fuel filter, a High Pressure (HP) fuel pump, a pump relief valve, a HP fuel filter, an actuator pressure regulator for hydraulic fuel operation, a torque-motor metering valve, a resistance temperature device, a delta pressure regulator, a flow-meter pressurizing valve, a fuel-shutoff solenoid valve.

• Fuel filter replacement every 8500 Flight Hours

Fuel filter replacement is recommended every 8500 Flight Hours.


PRIMARY FUEL FLOW
1 METERING MODULE
2 RESISTANCE TEMP DEVICE
TORQUE MOTOR
METERING VALVE
TM
ACTUATOR SUPPLY
ACTUATOR PRESSURE REGULATOR
FLOWMETER PRESSURIZING VALVE AND RESOLVER
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SEAL DRAIN
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FUEL DIVIDER SOLENOID VALVE
METERED FUEL FLOW
3-WAY SHUTOFF VALVE SOLENOID
SHAFT
FUEL FLOW DIVIDER
FUEL NOZZLE PRIMARY
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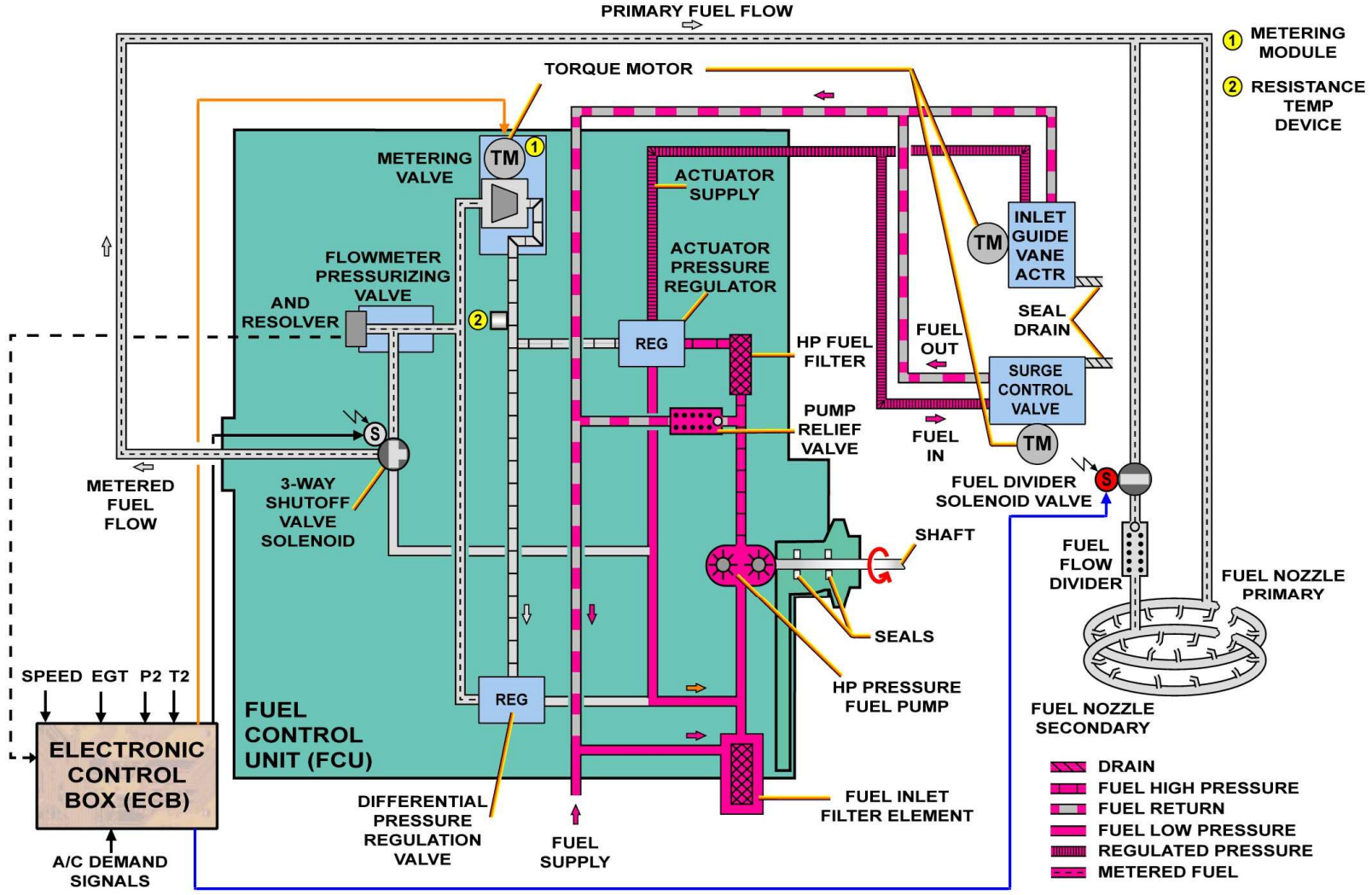
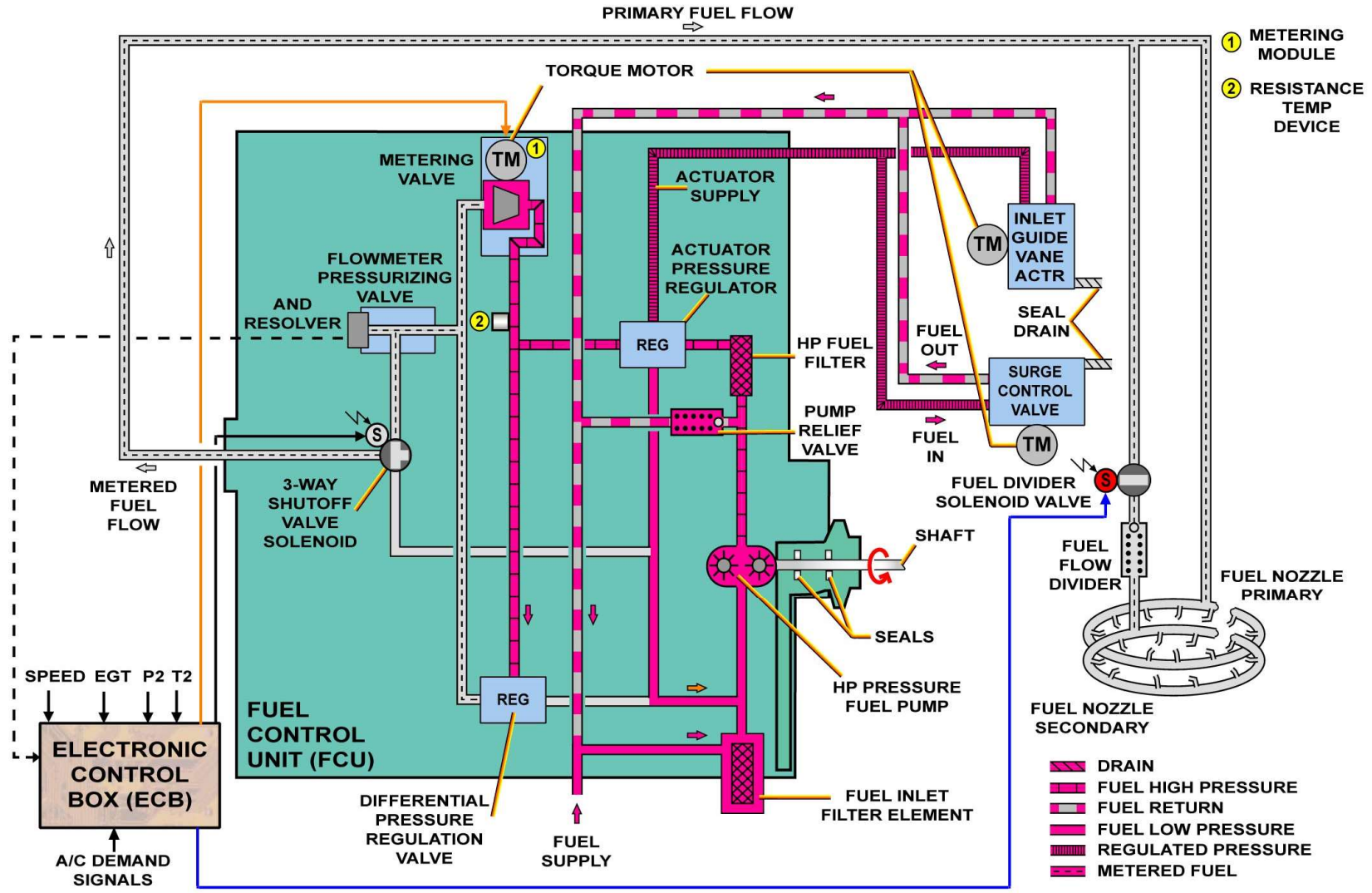
FUEL INLET FILTER ELEMENT
A/C DEMAND SIGNALS
DRAIN
FUEL HIGH PRESSURE
FUEL RETURN
FUEL LOW PRESSURE
REGULATED PRESSURE
METERED FUEL

MUSCLE PRESSURE

•Fuel muscle pressure 250 psig operates the surge control valve actuator and the IGV actuator
•Servo fuel return goes back to pump inlet
Additionally fuel muscle pressure 250 psig operates the surge control valve actuator for air release to the exhaust and the load-compressor IGV actuator. Servo fuel return goes back to the pump inlet.



•From Actuator Pressure to Metering Module + Differential Pressure Regulation Valve
From the Actuator Pressure Regulator fuel flow continues to the Metering Module and in parallel to the inlet of the Differential Pressure Regulation Valve



FUEL SCHEDULE

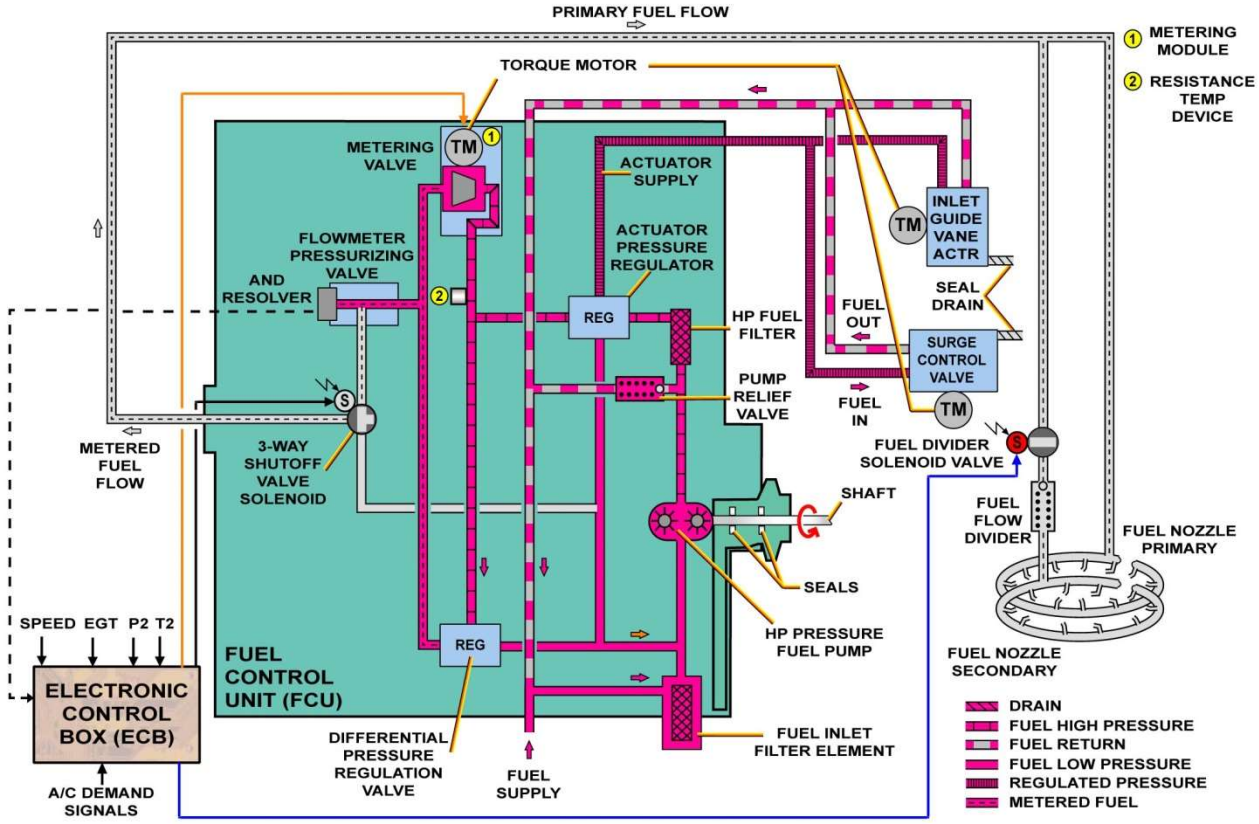
•The ECB:

- Schedules fuel flow
- Refers to flow meter pressurizing to correct fuel flow
- Refers to A/C bleed air demand and ELEC PWR to modulate on-speed fuel schedule

The Electronic Control Box (ECB) controls the fuel-metering valve through a torque motor.

The ECB:

- schedules fuel flow during start sequence, on-speed operation and shutdown sequence,
- refers to information on the flowmeter pressurizing valve to correct fuel flow and in relation to the fuel temperature (resistance-temperature device signal),
- modulates the on-speed fuel schedule to agree with the aircraft demand for bleed air and electrical power



FUEL SHUT-OFF

• ECB controls the 3-way solenoid valve:
  - To open during start sequence
  - To close during stop sequence

The ECB controls the fuel 3-way solenoid valve for positive fuel shut-off. The valve is controlled open during the start sequence and closed during the stop sequence. Fuel goes back to the pump inlet.

FLOW DIVIDER AND SOLENOID VALVE

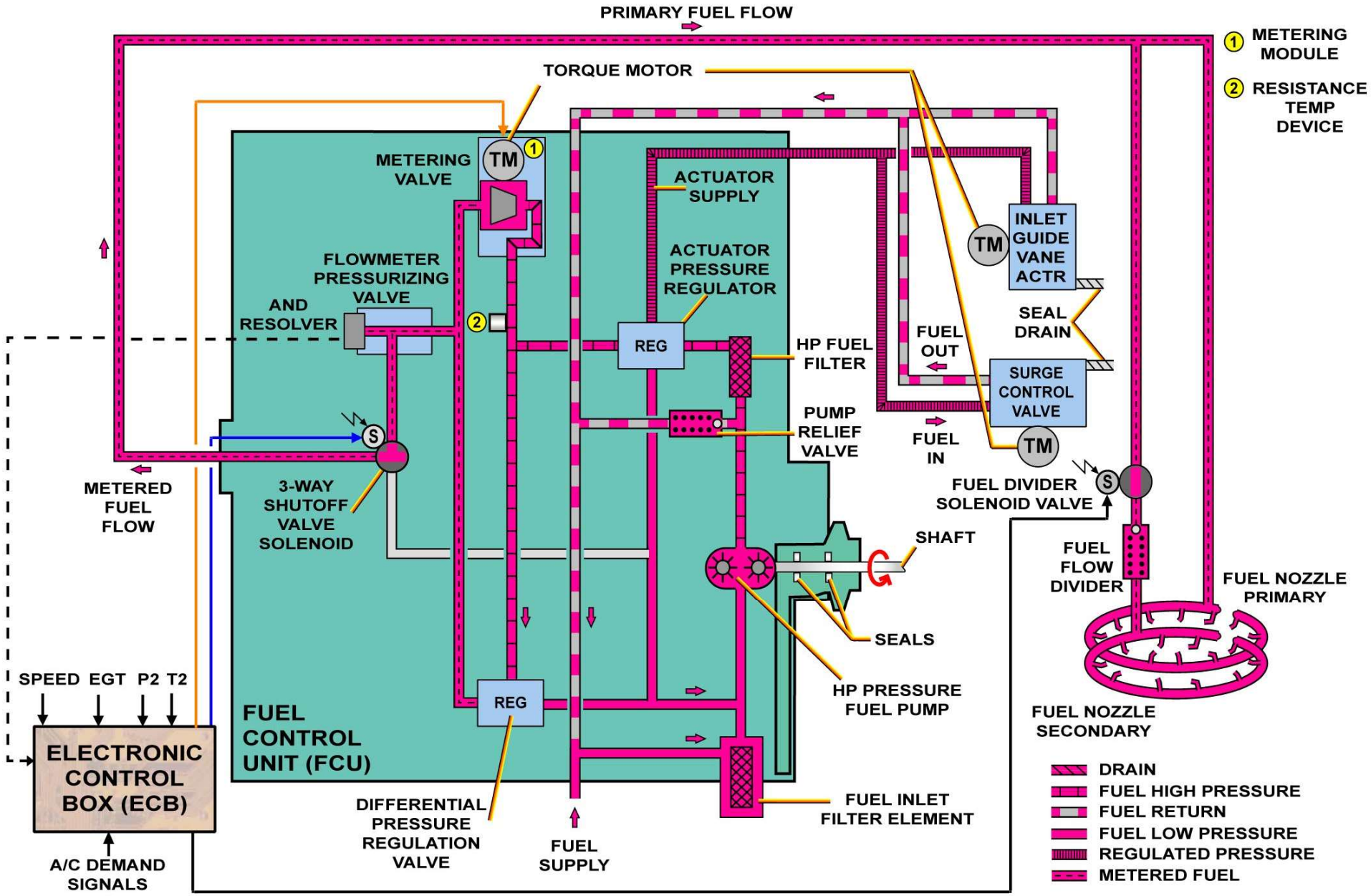
• Supplies fuel to the primary and secondary manifolds
•A usually open fuel solenoid and a check valve
•ECB energizes the solenoid valve to close until 30% speed and pushes all fuel flow through the primary nozzles

The flow divider supplies fuel in sequence to the primary and secondary manifolds. It has a usually open fuel solenoid and a check valve. During cold start or high altitude operation, the ECB energizes the solenoid valve to close during the first 30% speed of the Auxiliary Power Unit (APU) and all fuel flow is pushed through the primary nozzles for better engine acceleration.

FUEL SUPPLY

• Two fuel manifolds and 10 dual fuel-nozzles
•During APU start:
  - The primary fuel orifices are supplied
  - The secondary fuel orifices are supplied (fuel pressure > 125 psig)

Two fuel manifolds and 10 dual fuel-nozzles supply fuel. Each fuel-nozzle has a primary and a secondary fuel orifice. When APU start is selected, the primary fuel orifice is supplied and when the fuel pressure is more than 125 psig the check valve in the flow divider assembly opens to supply the secondary fuel orifice. During on-speed operation, the two orifices are supplied.


PRIMARY FUEL FLOW
TORQUE MOTOR
METERING VALVE
TM
1
ACTUATOR SUPPLY
ACTUATOR PRESSURE REGULATOR
FLOWMETER PRESSURIZING VALVE AND RESOLVER
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REG
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METERED FUEL FLOW
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SHAFT
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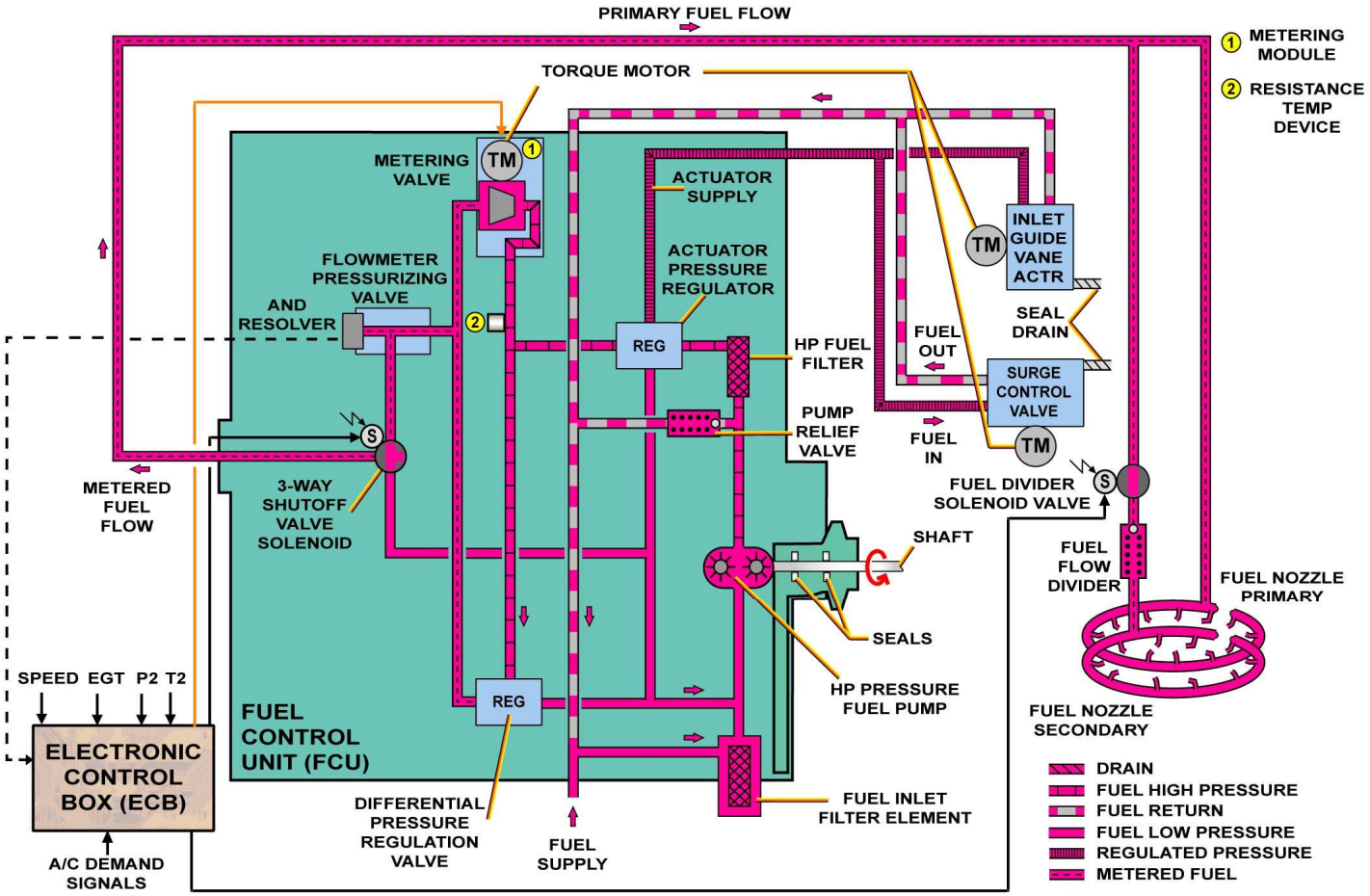
FUEL NOZZLE SECONDARY
SPEED EGT P2 T2
ELECTRONIC CONTROL BOX (ECB)
FUEL CONTROL UNIT (FCU)
DIFFERENTIAL PRESSURE REGULATION VALVE
FUEL SUPPLY
FUEL INLET FILTER ELEMENT
A/C DEMAND SIGNALS
1 METERING MODULE
2 RESISTANCE TEMP DEVICE
DRAIN
FUEL HIGH PRESSURE
FUEL RETURN
FUEL LOW PRESSURE
REGULATED PRESSURE
METERED FUEL

APU SHUTDOWN

•3-Way Shutoff Solenoid Valve to closed position
- fuel back to the pump inlet.

•Fuel is trapped in the line to the Primary and Secondary Nozzles
- 2 fuel manifolds are still filled up with remaining fuel.

The 3-Way Shutoff Solenoid Valve is brought to the closed position and the fuel is now given back to the pump inlet.
The fuel is trapped in the line to the Primary and Secondary Nozzles. The 2 fuel manifolds are still filled up with remaining fuel.



APU Oil System Description and Operation

GENERAL

Oil system description:

- Storage
- Supply
- Scavenge
- Venting
- Control
- Protection
- Monitoring

The oil system of the Auxiliary Power Unit (APU) lubricates and decreases the temperature of the power section, load compressor, gearbox and AC generator.

This system is made of:

- storage,
- supply,
- scavenge,
- venting,
- control,
- protection,
- monitoring.

STORAGE

• AGB sump contains 6.26 l (1.65 US gal)

•Oil reservoir filled by gravity or pressure

•Oil-level sight glass

•Magnetic chip detector and oil drain plug

•Oil heater

The sump of the APU Accessory Gearbox (AGB) is the oil reservoir.

The AGB sump contains 6.26 l (1.65 US gal) of oil. The oil reservoir can be filled by gravity or by pressure.

The AGB has:

- an oil fill cap for gravity filling,
- optional pressure oil servicing with a pressure fill and overfill port,
- an oil-level sight glass with FULL and ADD marks,
- a magnetic chip detector and oil drain plug installed at the lowest point of the AGB,
- an oil heater.

CONTROL

• ECB only controls de-oiling valve

•Electrically-controlled de-oiling solenoid valve opens to make sure of cold start conditions and decrease load on pressure pump

•Solenoid valve open during start-up to 60% RPM:

- Oil sump below -6.7ºC (+20�F)
- Or A/C above 10,000 ft
- Or APU fuel temperature below -12.2 º C (+10�F)

•De-oiling solenoid valve opens during shutdown between 50% and 7% APU speed

The Electronic Control Box (ECB) only controls the de-oiling valve in the oil system. The de-oiling solenoid valve is electrically opened during APU start to make sure of cold start conditions and to decrease the load on the pressure pump. The solenoid valve is open during start-up to 60% RPM when:

- the oil sump temperature is below -6.7 º C (+20�F),
- or the A/C altitude is above 10,000 ft (P2<10,1 psia),
- or the APU fuel temperature is below -12.2 º C (+10�F).

The valve is energized open during every APU shutdown between 50% and 7% speed.

PROTECTION

• ECB gives protection to APU if there is an oil system malfunction

•ECB monitors oil pressure and temperature

•ECB starts automatic shutdown if:

- Gearbox temp threshold 162.78 º C (325�F)
- Low oil pressure threshold 33 psi
- Oil filter clogging

The ECB gives protection to the APU if there is an oil system malfunction. The ECB monitors oil pressure and oil temperature. If one of the oil parameters is out of limit, the ECB starts an automatic APU shutdown without time delay:

- gearbox high oil temp threshold: 162.78 º C (325�F),
- oil low pressure: 33 psi.

The ECB also stops the APU if a delta pressure switch at the scavenge filter or at the lubrication filter shows impending filter clogging.

MONITORING

• To increase APU life

•Oil sump installed with low-level switch to show information in cockpit

•Level at "ADD" mark APU can operate for 10 hours max

•Magnetic drain plug lets oil drain from sump and attracts particles

The oil system is monitored to increase the APU life. The oil sump is installed with a low-level switch to show maintenance information in the cockpit. When the level is at the "ADD" mark 4.60 l (1.22 US gal), the APU can continue to operate for 10 hours maximun. This changes with the different operating attitudes of the A/C in flight. A magnetic drain plug, put fully in the APU oil, lets the oil drain from the sump and attracts ferrous metal particles.

OIL HEATER (OPTION)

• Oil heater is an Option

•Heater is supplied with 115VAC:

- oil temperature below 16 º C (61 °F) and
- APU master switch released out

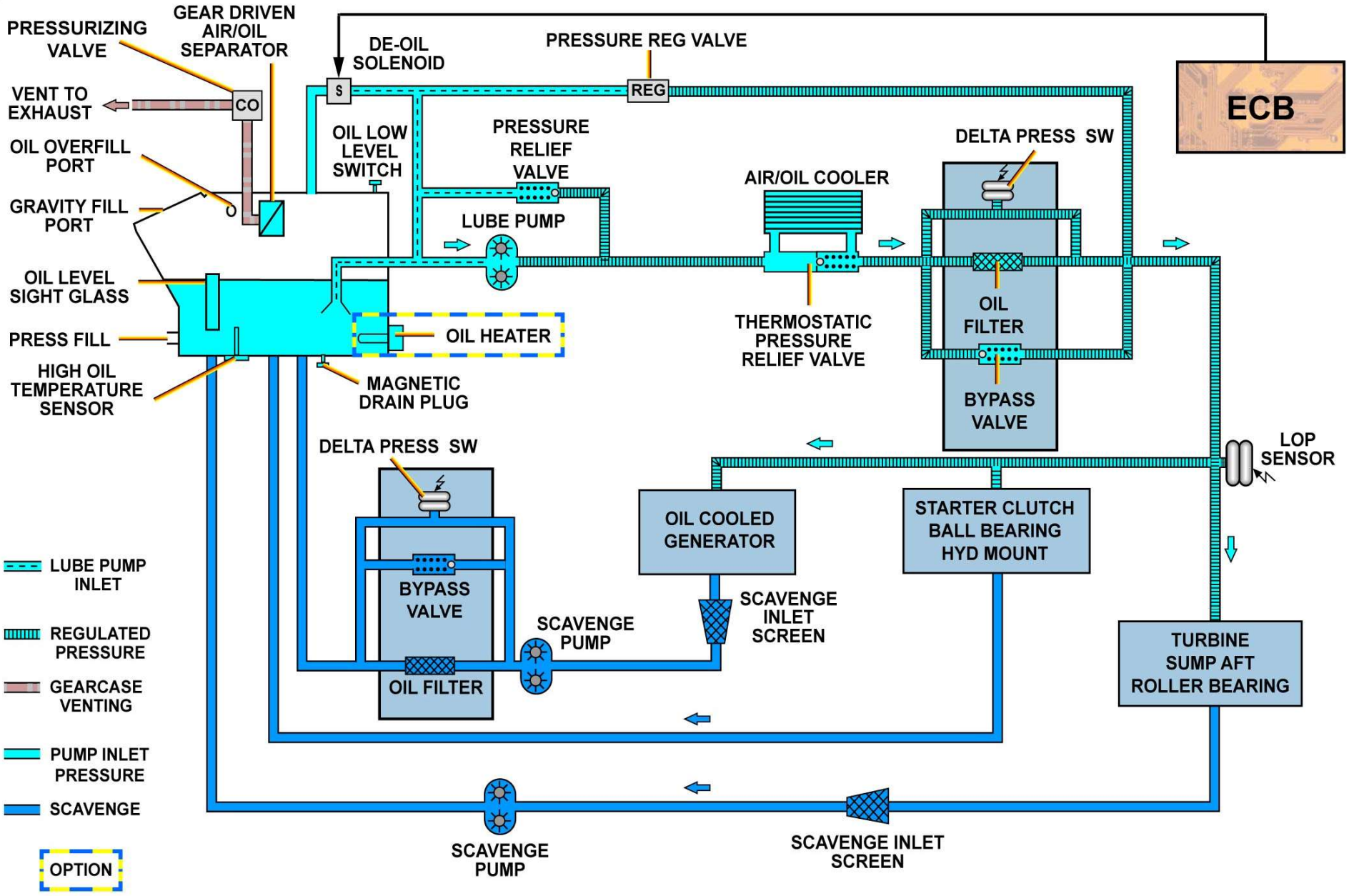
•Oil heater is switched off:

- oil temperature increases above 49 º C (120 °F) or
- master switch is selected ON

The control of the oil heater is independent of the ECB. When the oil temperature is below 16 º C (61 °F) and the APU master switch is released out, the heater is supplied with 115VAC.

The oil heater is switched off when the oil temperature increases above 49 º C (120 °F) or the master switch is selected ON.

The oil heater is an option.

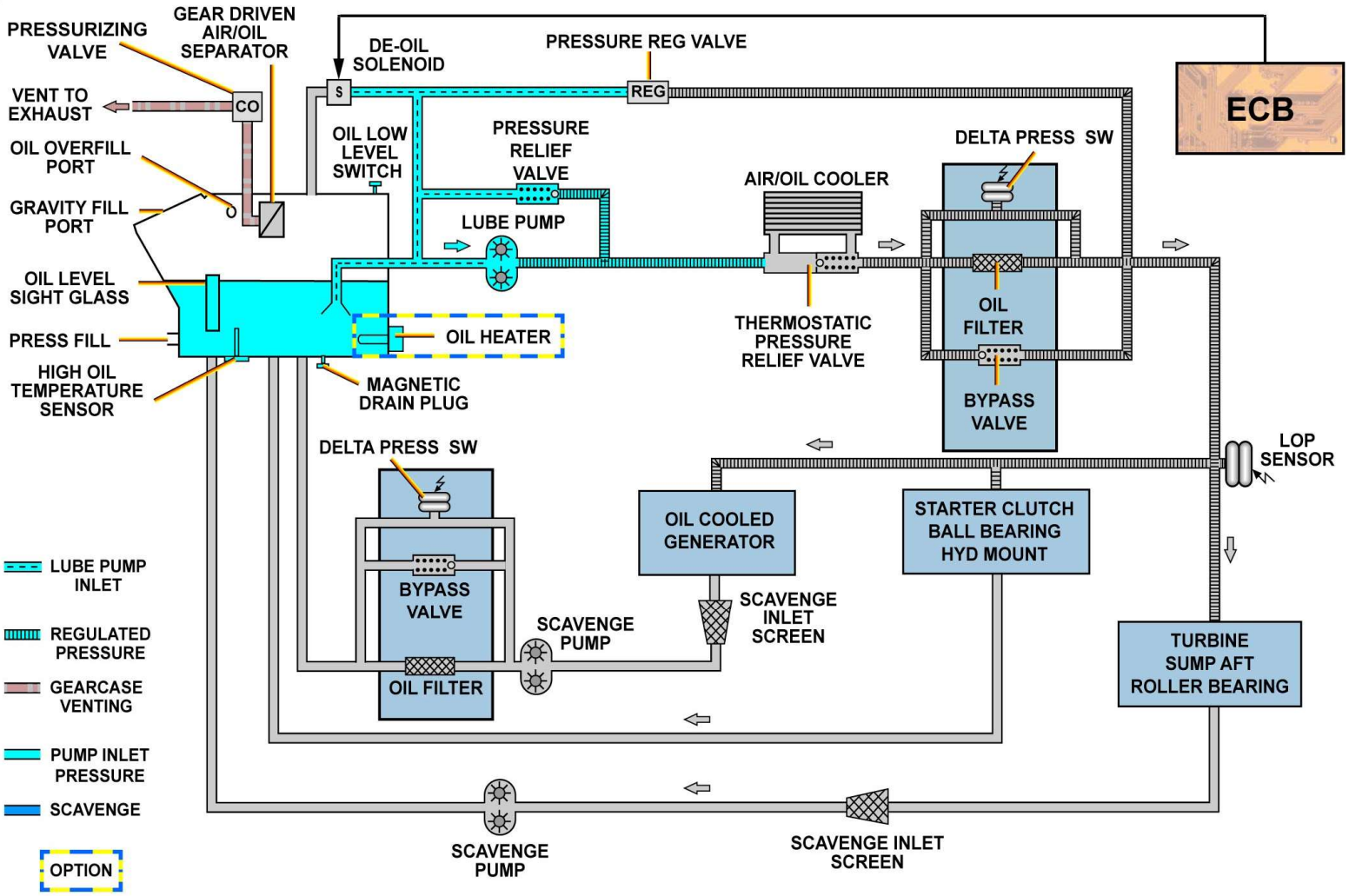

PRESSURIZING VALVE
GEAR DRIVEN AIR/OIL SEPARATOR
DE-OIL SOLENOID
PRESSURE REG VALVE
ECB
VENT TO EXHAUST
CO
S
REG
OIL OVERFILL PORT
OIL LOW LEVEL SWITCH
PRESSURE RELIEF VALVE
DELTA PRESS SW
AIR/OIL COOLER
GRAVITY FILL PORT
LUBE PUMP
OIL LEVEL SIGHT GLASS
OIL FILTER
PRESS FILL
OIL HEATER
THERMOSTATIC PRESSURE RELIEF VALVE
HIGH OIL TEMPERATURE SENSOR
MAGNETIC DRAIN PLUG
BYPASS VALVE
LOP SENSOR
DELTA PRESS SW
OIL COOLED GENERATOR
STARTER CLUTCH BALL BEARING HYD MOUNT
BYPASS VALVE
SCAVENGE PUMP
SCAVENGE INLET SCREEN
TURBINE SUMP AFT ROLLER BEARING
OIL FILTER
LUBE PUMP INLET
REGULATED PRESSURE
GEARCASE VENTING
PUMP INLET PRESSURE
SCAVENGE
OPTION
SCAVENGE PUMP
SCAVENGE INLET SCREEN

SUPPLY

•Three-element gerotor pressure pump pulls oil

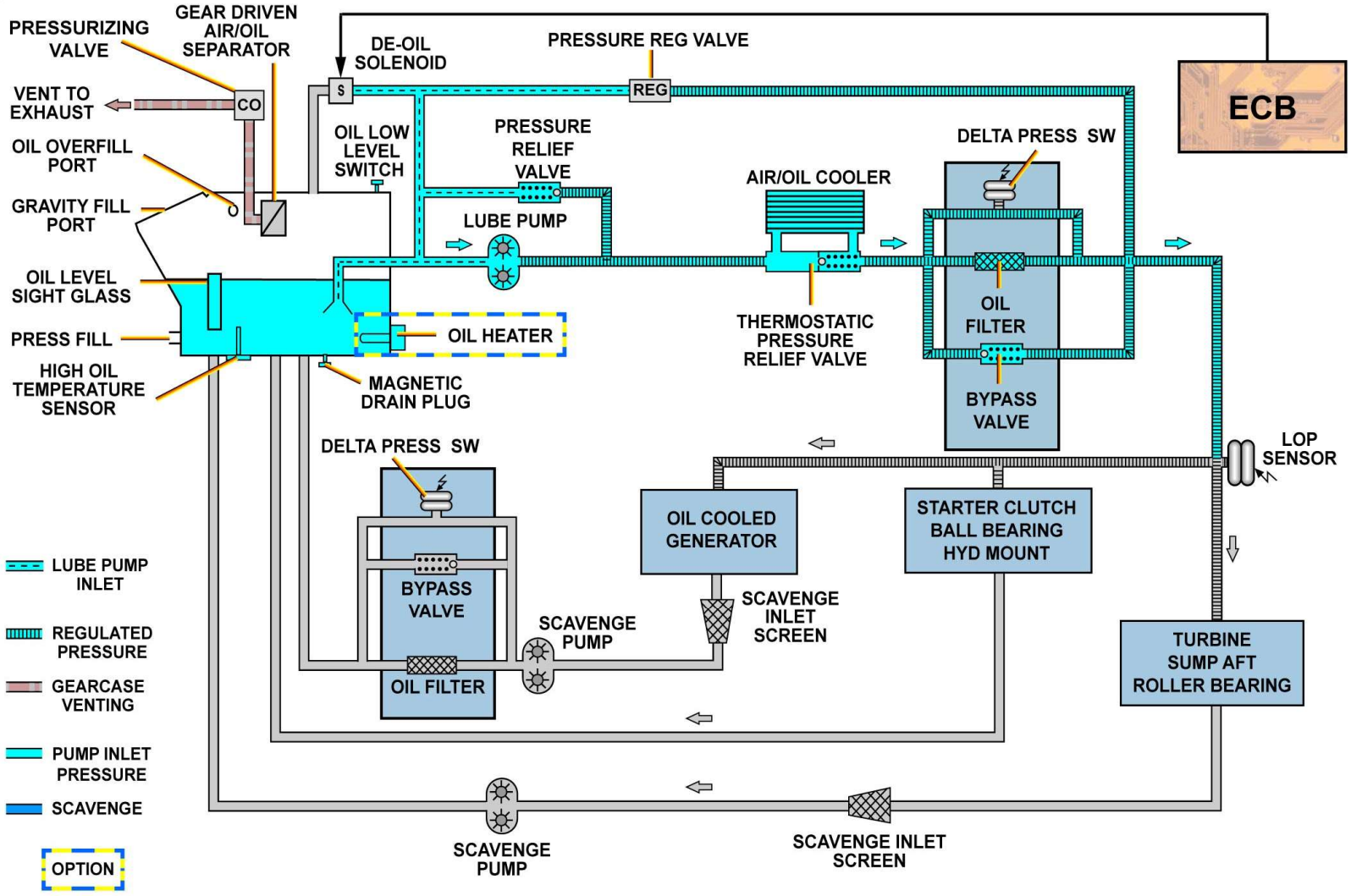
•Pressure-regulating and ultimate-relief valve assembly keeps constant pressure for oil supply to engine and generator

A three-element gerotor pressure pump pulls the oil from the sump. A pressure-regulating valve and ultimate-relief valve assembly keeps a constant lube supply pressure for oil supply to the engine and generator and prevents over-pressurization of the lube system.

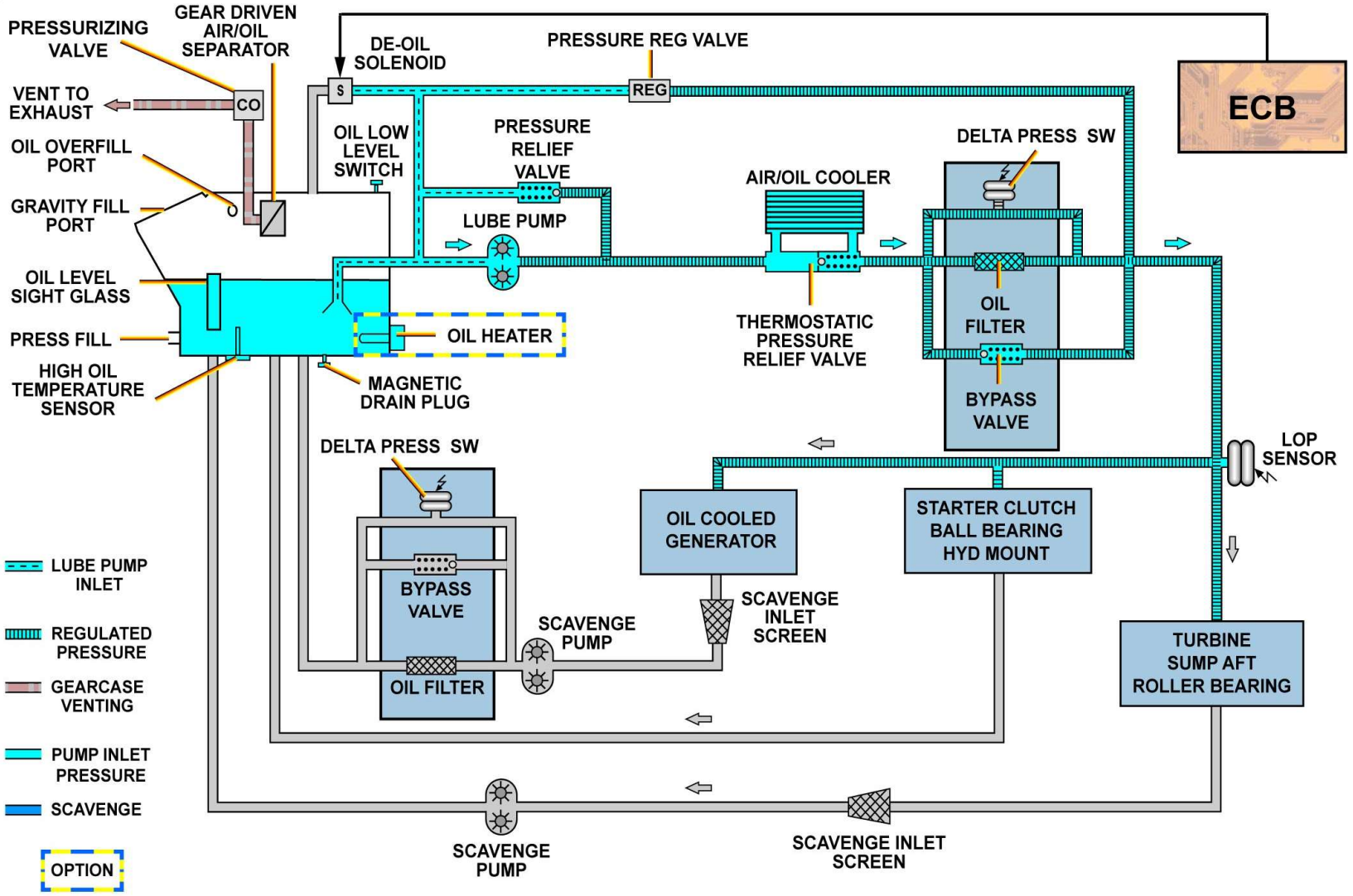


•Oil goes through cooler and disposable lubrication filter

Pressure-regulated oil goes through a cooler and a disposable filter. The bypass valve opens at an oil temperature below 60°C (140 °F) or when there is a differential pressure between 55 - 60 psi around the oil cooler.



•Oil sent to cooling fan splines, APU spline shaft, APU supporting bearings rear and front, gearbox pinions and electrical generator
The oil is then sent to the cooling fan splines, the APU spline shaft, the APU supporting bearings rear and front, the gearbox pinions and the electrical AC generator.



SCAVENGE

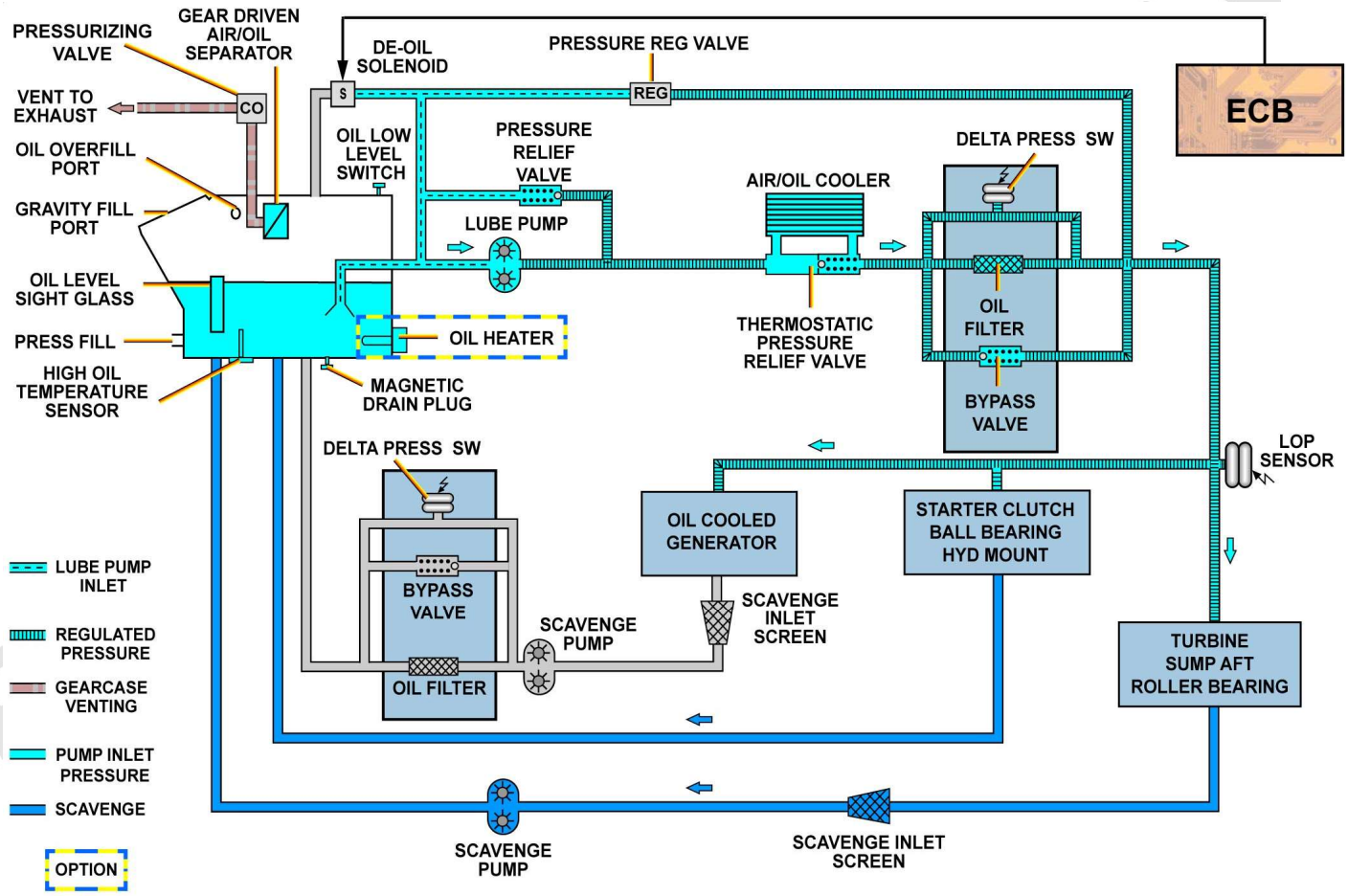
• Scavenged returned to the oil reservoir with one scavenge pump.

•Oil is returned to the reservoir by gravity:

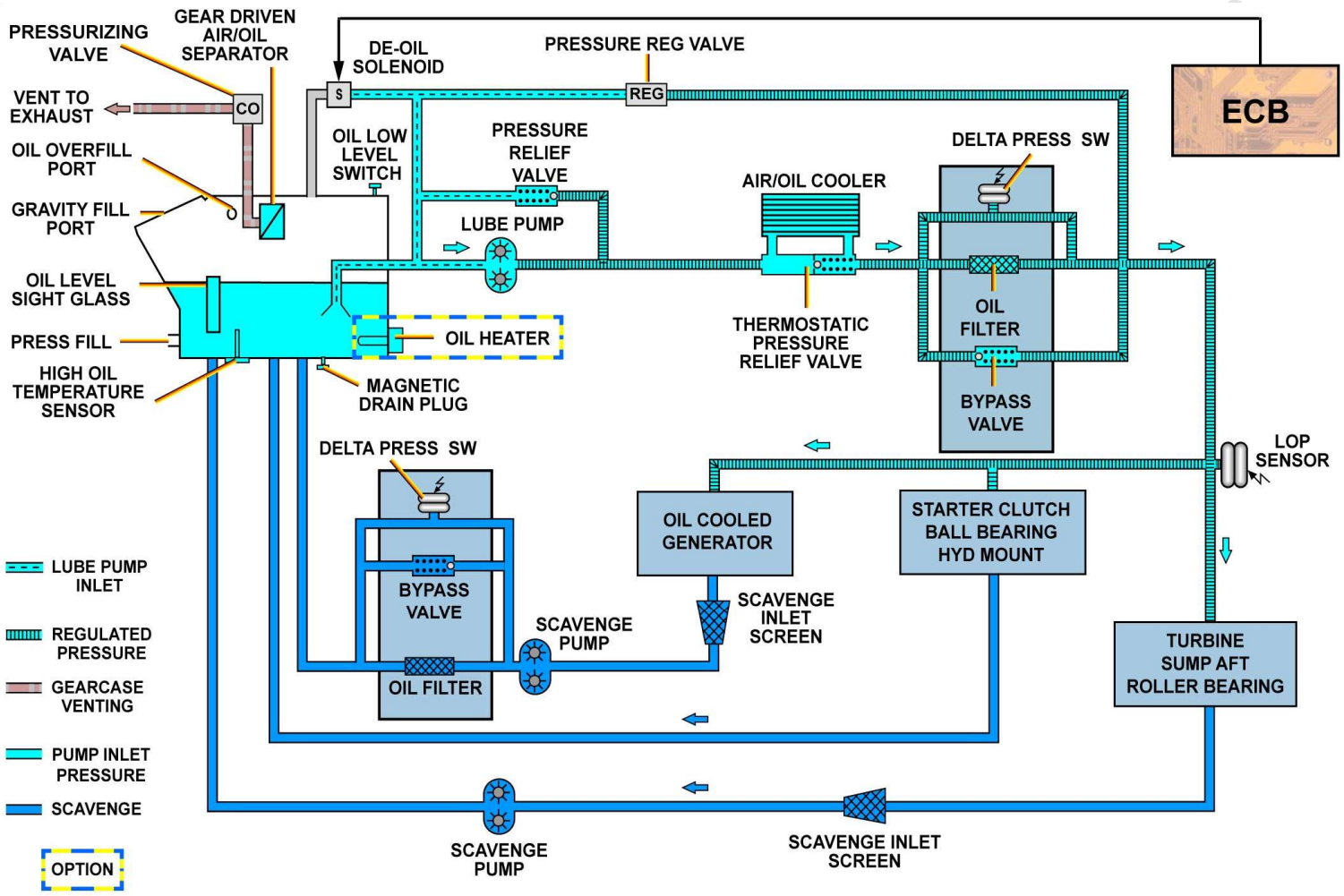
- lubricates the gears
- the starter clutch and bearings of the gearbox

The scavenged oil from the turbine sump is returned to the oil reservoir with one scavenge pump.

The oil which lubricates the gears, the starter clutch and bearings of the gearbox, is returned to the reservoir by gravity.



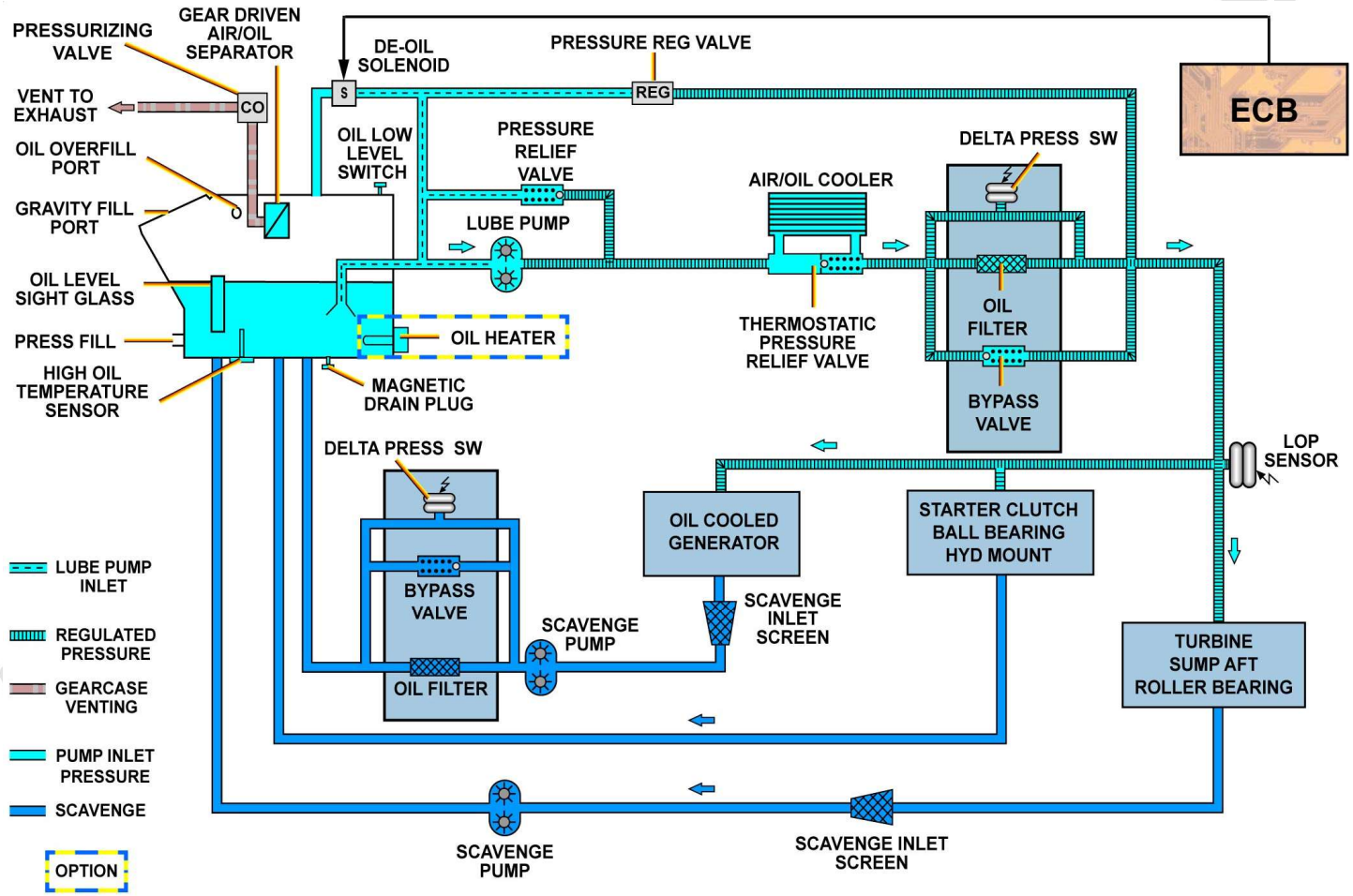
•Scavenged oil from the generator sump returned to the oil reservoir with one scavenge pump.
•Generator scavenge oil is filtered and supplied to the oil reservoir: oil reservoir no contaminated
The scavenged oil from the generator sump is returned to the oil reservoir with one scavenge pump.
The generator scavenge oil is filtered from the generator scavenge oil-filter and then supplied to the oil reservoir. This makes sure that no contaminated oil returns from the generator to the oil reservoir.



VENTING

•Oil from generator sent against gearbox wall to remove air
•Air/oil separator removes oil particles
•Oil-free air released in APU exhaust

The oil from the generator is sent against the gearbox wall; this removes the air, that is mixed with the oil. An air/oil separator removes the oil particles from the gearbox air. This oil-free air is released in the APU exhaust.



DE-OILING SOLENOID

• ECB controls the de-oiling solenoid valve

The only component of the oil system controlled by the Electronic Control Box (ECB) is the de-oiling valve.

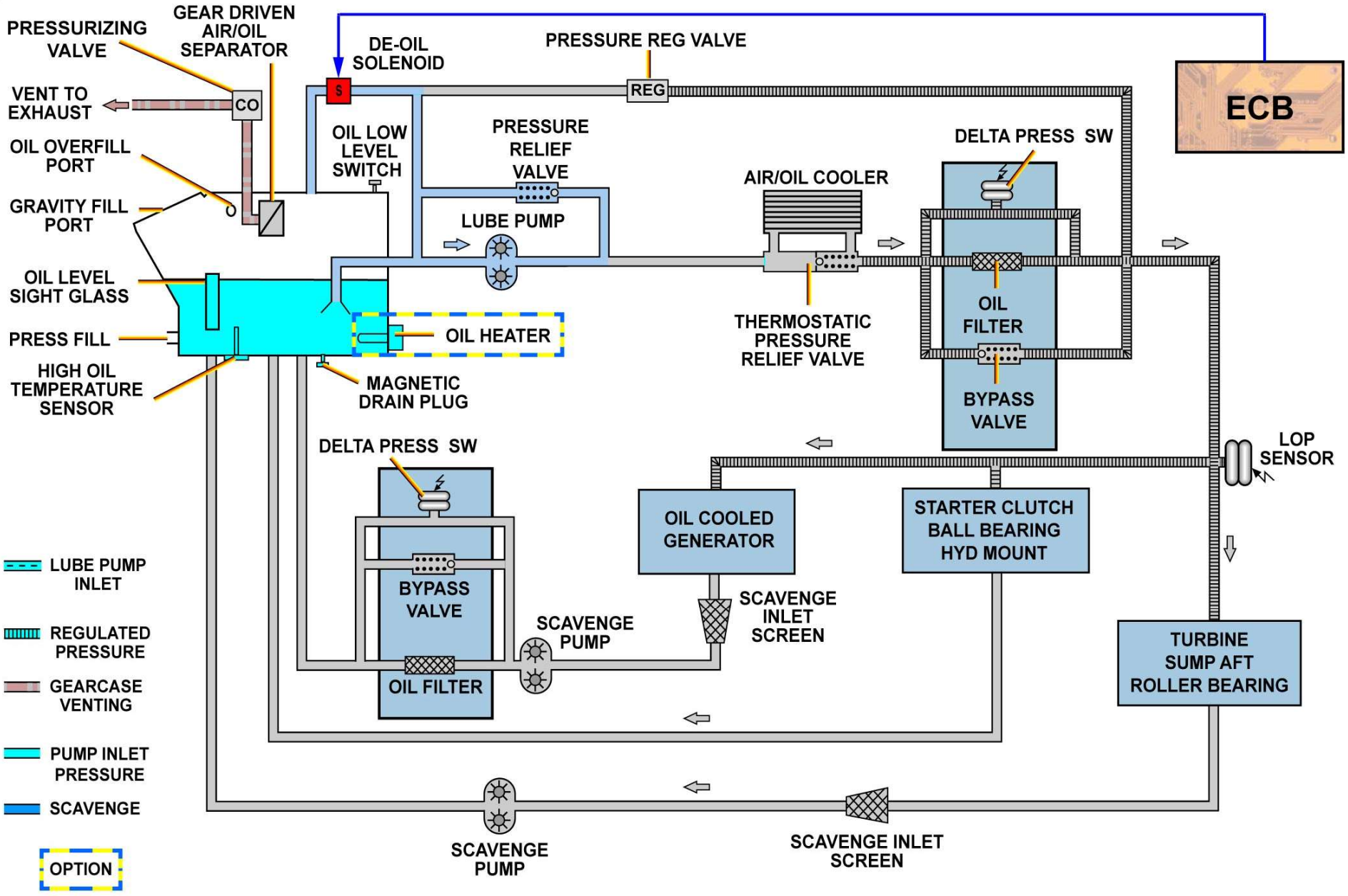
DURING COLD START

• De-oiling valve electrically controlled during start

•De-oiling solenoid logic: the solenoid valve is open during start up to 60% rpm when:

- the oil sump temperature is below -6.7 deg.C (+19.94 deg.F) or
- the aircraft altitude is more than 20,000 ft or
- the fuel temperature is below -12.2 deg.C (+10.04 deg.F)

During the cold start condition; the oil has a high viscosity. The de-oiling solenoid valve reduces the oil pressure pump load during the APU start by allowing air to enter the inlet of the oil supply pump. The solenoid valve is open during start up to 60% rpm when the oil sump temperature is below -6.7 deg.C (+19.94 deg.F) or the aircraft altitude is more than 20,000 ft or the fuel temperature is below -12.2 deg.C (+10.04 deg.F).

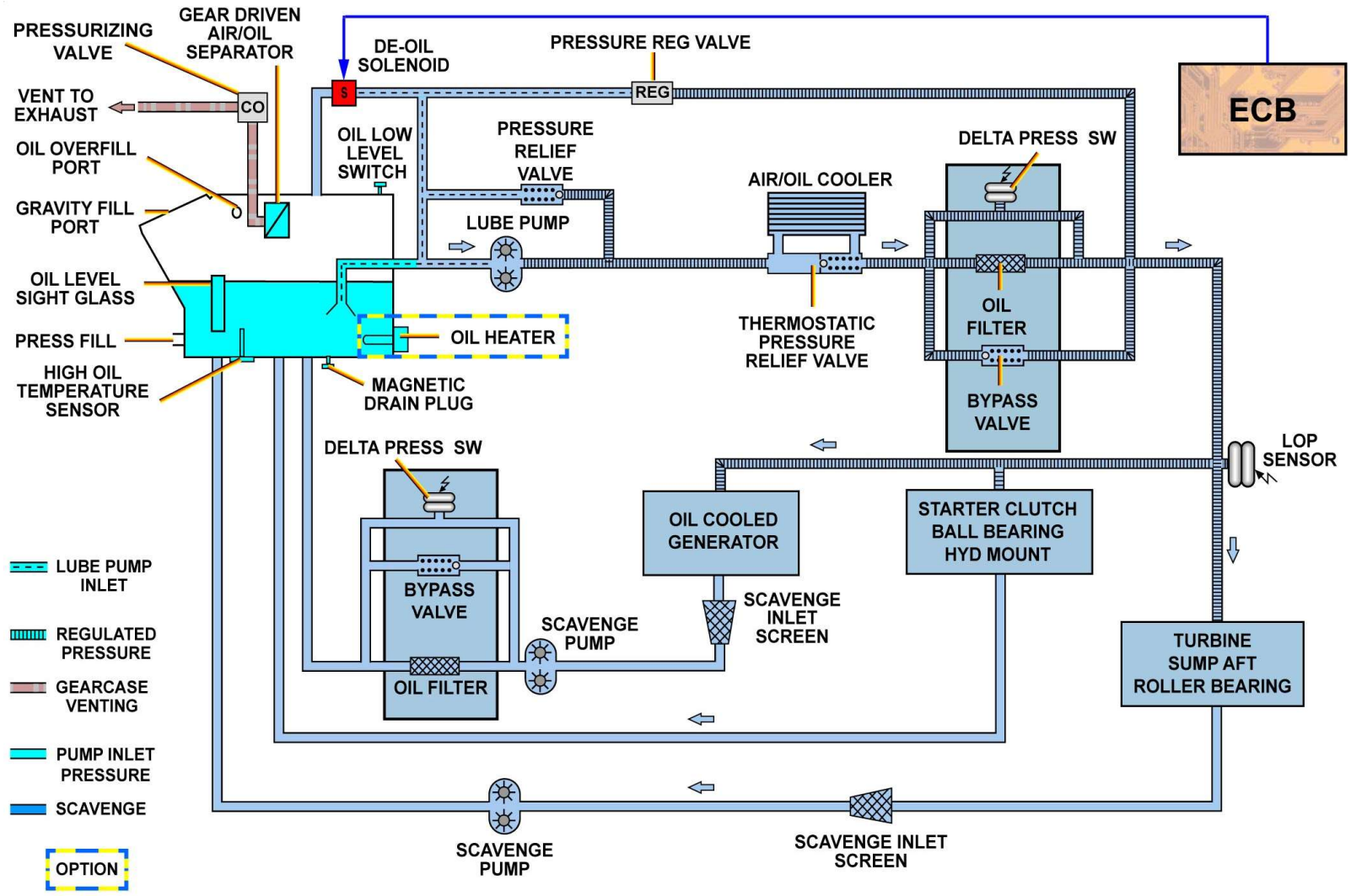

PRESSURIZING VALVE
GEAR DRIVEN AIR/OIL SEPARATOR
DE-OIL SOLENOID
PRESSURE REG VALVE
ECB
VENT TO EXHAUST
CO
S
REG
OIL OVERFILL PORT
OIL LOW LEVEL SWITCH
PRESSURE RELIEF VALVE
DELTA PRESS SW
GRAVITY FILL PORT
LUBE PUMP
AIR/OIL COOLER
OIL LEVEL SIGHT GLASS
OIL FILTER
PRESS FILL
OIL HEATER
THERMOSTATIC PRESSURE RELIEF VALVE
HIGH OIL TEMPERATURE SENSOR
MAGNETIC DRAIN PLUG
BYPASS VALVE
LOP SENSOR
DELTA PRESS SW
OIL COOLED GENERATOR
STARTER CLUTCH BALL BEARING HYD MOUNT
BYPASS VALVE
SCAVENGE PUMP
SCAVENGE INLET SCREEN
TURBINE SUMP AFT ROLLER BEARING
OIL FILTER
LUBE PUMP INLET
REGULATED PRESSURE
GEARCASE VENTING
PUMP INLET PRESSURE
SCAVENGE
OPTION
SCAVENGE PUMP
SCAVENGE INLET SCREEN

DURING SHUT DOWN

• APU shutdown

- To prevent coking of the oil remaining in the bearing chambers.

During the APU shutdown, the de-oiling solenoid valve prevents the coking of the oil remaining in the bearing chambers.
Therefore the ECB opens the de-oiling solenoid valve during shut down between 55% - 7%.



APU Air System Description and Operation

GENERAL

• APU air system:
- Bleed supply
- Bleed control
- Surge protection
- Oil cooling
- Compartment cooling
- Oil vent
- Control
- Monitoring

The Auxiliary Power Unit (APU) load compressor supplies the APU bleed air. The quantity changes with the different bleed air demands of the pneumatic system. This system includes:
- bleed supply,
- bleed control,
- surge protection,
- oil cooling,
- compartment cooling,
- oil vent,
- control,
- monitoring.

BLEED SUPPLY

• Load control valve control system
•Butterfly valve, APU BLEED P/B switch controls
•APU BLEED ON signal sent to ECB via BMC

Bleed air supply to the A/C pneumatic system is controlled by a load control valve. The pneumatically-actuated CLOSE/OPEN butterfly valve, which allows or stops the bleed airflow from the APU to the A/C users, is controlled by the Electronic Control Box (ECB) and opens when the APU BLEED P/BSW is set to the ON position. The "APU BLEED" P/B sends "ON" signal to the ECB via the Bleed Monitoring Computer (BMC).

BLEED CONTROL

• IGV controls
•Fuel-powered actuator

The quantity of air necessary to the aircraft bleed users is controlled by the opening angle of the load compressor Inlet Guide Vanes (IGVs). The IGVs are moved by a fuel-powered actuator (IGC-Actuator). Pressurized fuel is supplied by the internal pressure regulator part of the APU Fuel Control Unit.

SURGE PROTECTION

• Surge control valve discharges excess of air
•FCU pressure 250 to 300 psig

Load compressor surge protection is ensured by a surge control valve, which discharges the excess of air in the exhaust. The surge control valve is hydraulically operated for accurate and fast operation. The hydraulic fluid is high pressure fuel from the Fuel Control Unit (FCU) with approximately 250 psig.

OIL COOLING

• Fan draws air from inlet plenum to oil cooler
•Air overboard

A gearbox-driven fan draws air from the inlet plenum and forces it to pass through the oil cooler. After leaving the oil cooler, the air is discharged overboard.

COMPARTMENT COOLING

• Air supplied by fan
•Cooling fan outlet duct
•Natural convection ventilates the APU compartment

Air supplied by the fan, driven by one of the gears of the gearbox, is also used for APU compartment cooling. Cooling air flows through the outlets located on the cooling fan outlet duct. Natural convection ventilates the APU compartment through a vent grill in the upper left area of the compartment when the APU is not in operation.

OIL VENT

• APU exhaust

•Air/oil separator action

The gearbox is vented to the APU exhaust. The air is bled after an air/oil separator action.

CONTROL

• ECB controls:

- APU inlet pressure, temperature
- Load compressor discharge pressure sensor and differential pressure sensor
- Command and feedback signals
- A/C demands

The ECB controls the air system using several parameters from the following components installed on the APU:

- APU inlet pressure (P2) and temperature (T2) sensors,
- load compressor discharge pressure sensor (PT) and differential pressure sensor (DP),
- command and feedback signals from the actuators and the valves (IGV actuator, Load Control Valve and Surge Control Valve),
- A/C demands: Main Engine Start (MES) and Environmental Control System (ECS).

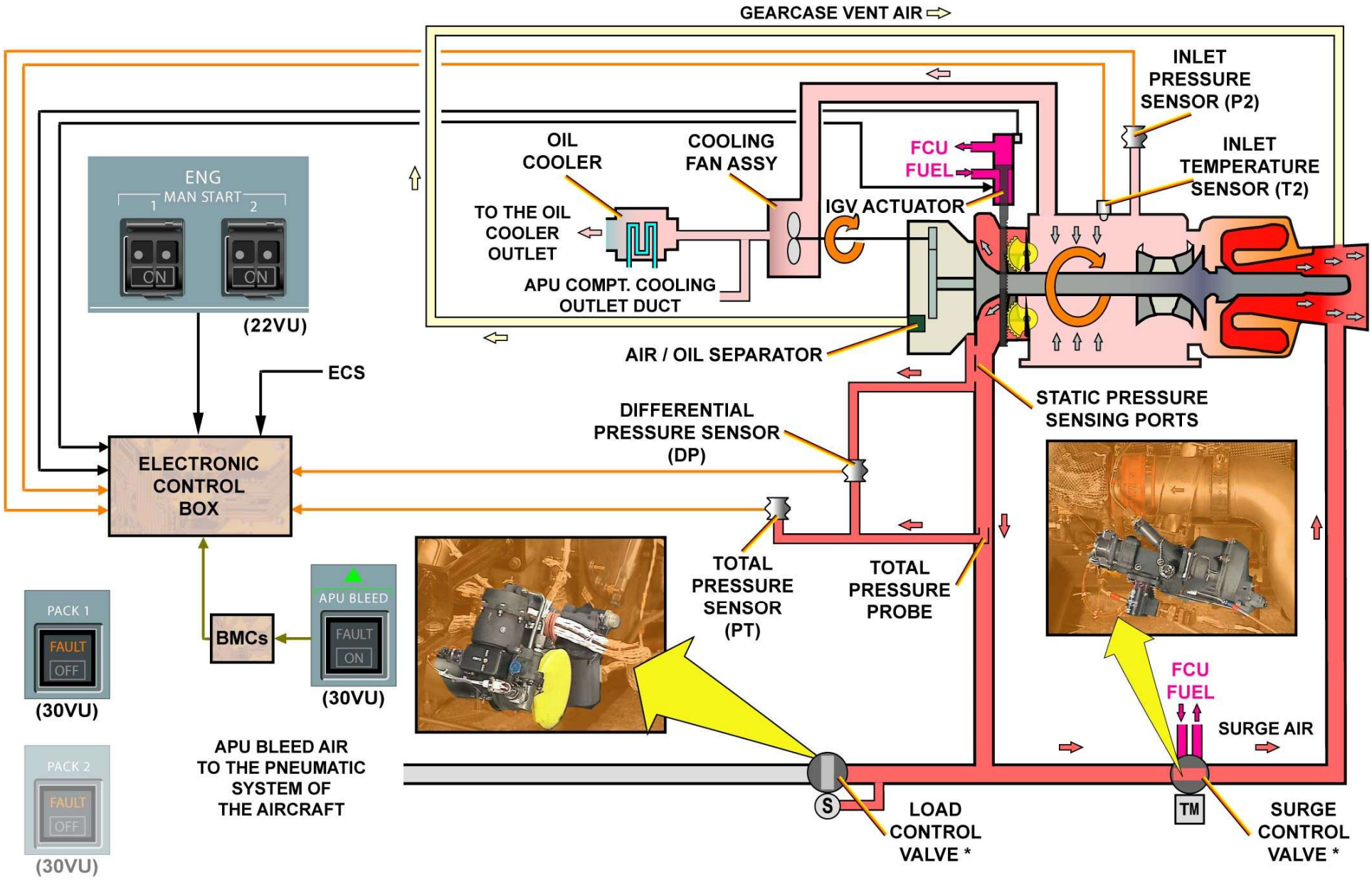
MONITORING

• Visual position indicators:

- Load control valve
- Surge control valve

To help maintenance and troubleshooting, the load control valve and the surge control valve are equipped with visual position indicators.

The ECB receives feed back signals about the position of the IGVs, the load control valve and the surge control valve

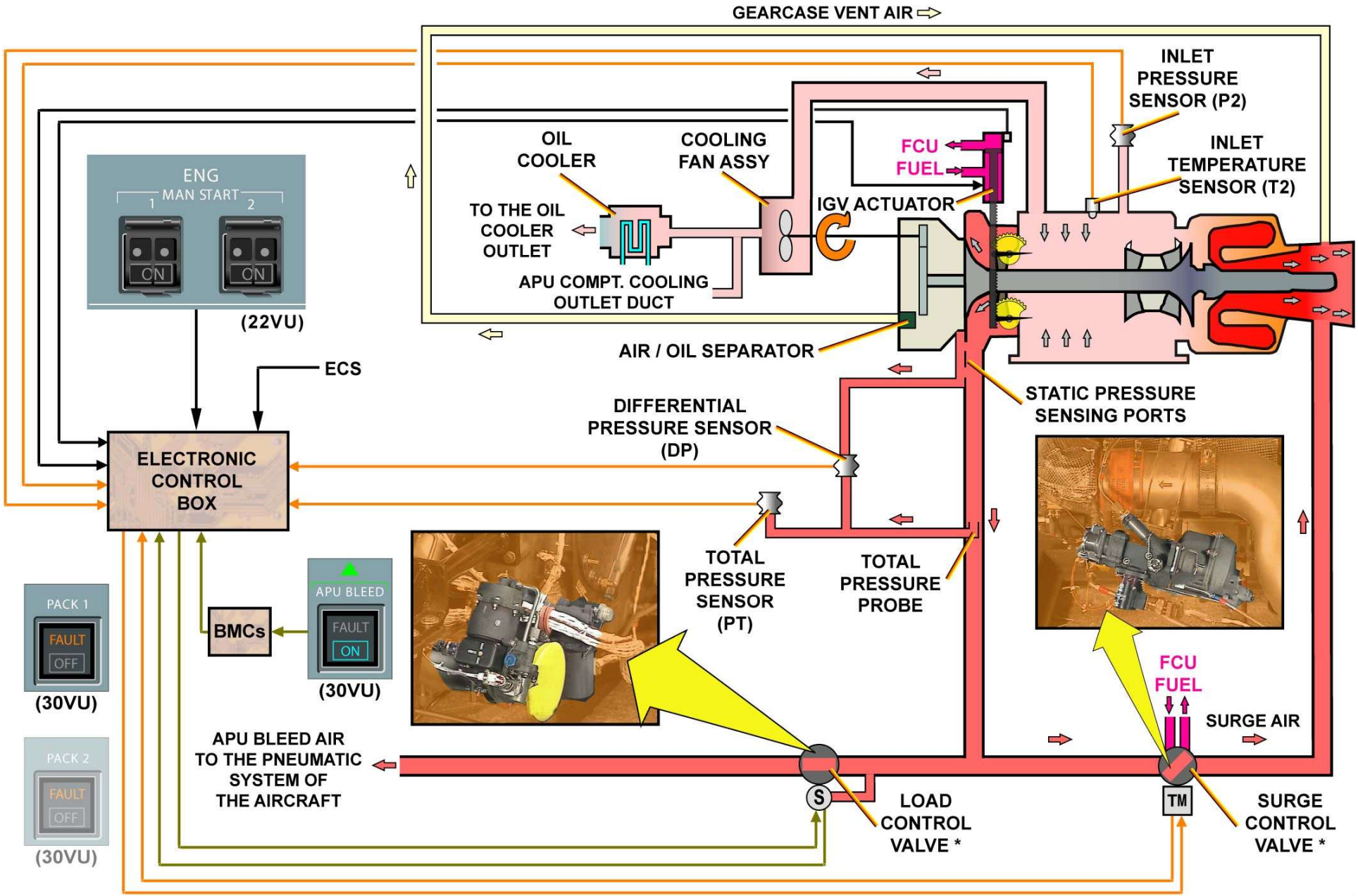

GEARCASE VENT AIR
INLET PRESSURE SENSOR (P2)
INLET TEMPERATURE SENSOR (T2)
OIL COOLER
COOLING FAN ASSY
FCU FUEL
IGV ACTUATOR
TO THE OIL COOLER OUTLET
APU COMPT. COOLING OUTLET DUCT
AIR / OIL SEPARATOR
ENG MAN START
1
2
ON
ON
(22VU)
ECS
ELECTRONIC CONTROL BOX
DIFFERENTIAL PRESSURE SENSOR (DP)
STATIC PRESSURE SENSING PORTS
TOTAL PRESSURE SENSOR (PT)
TOTAL PRESSURE PROBE
PACK 1
FAULT
OFF
(30VU)
BMCs
APU BLEED
FAULT
ON
(30VU)
PACK 2
FAULT
OFF
(30VU)
APU BLEED AIR TO THE PNEUMATIC SYSTEM OF THE AIRCRAFT
FCU FUEL
SURGE AIR
S
TM
LOAD CONTROL VALVE *
SURGE CONTROL VALVE *

APU RUNNING AT 99%
BLEED PUSH BUTTON ON

•APU BLEED P/B pushed: ON light comes on
•BMCs and ECB opens the LCV

- LCV open to let bleed air flow enter into the A/C pneumatic system
- ECB commands SCV to closed position
- LCV and SCV gives their position feedback to ECB

After the APU Bleed P/B is pushed, the blue ON light in the P/B comes on and a signal is sent to the two BMCs and to the ECB to open the Load Control Valve (LCV).
The LCV Solenoid will be energized to let the LCV open and to let bleed air flow into the supply duct of the Aircraft pneumatic system.
To make sure a pressure build-up occurs in the Aircraft Bleed supply duct, the ECB commands the Surge Control Valve (SCV) to the closed position and then to modulate to prevent surge conditions.
The LCV (through a micro-switch) and the SCV (with an LVDT) send valve position feed back to the ECB.


GEARCASE VENT AIR
INLET PRESSURE SENSOR (P2)
INLET TEMPERATURE SENSOR (T2)
OIL COOLER
COOLING FAN ASSY
FCU FUEL
IGV ACTUATOR
TO THE OIL COOLER OUTLET
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ENG MAN START
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(22VU)
ECS
ELECTRONIC CONTROL BOX
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STATIC PRESSURE SENSING PORTS
TOTAL PRESSURE SENSOR (PT)
TOTAL PRESSURE PROBE
PACK 1
FAULT
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(30VU)
BMCs
APU BLEED
FAULT
ON
(30VU)
FCU FUEL
SURGE AIR
APU BLEED AIR TO THE PNEUMATIC SYSTEM OF THE AIRCRAFT
PACK 2
FAULT
OFF
(30VU)
S
LOAD CONTROL VALVE *
TM
SURGE CONTROL VALVE *

BLEED AND PACK P/B PRESSED

• ECB receives command signal from ECS control computer

- ECB sends a retract command signal to IGV actuator

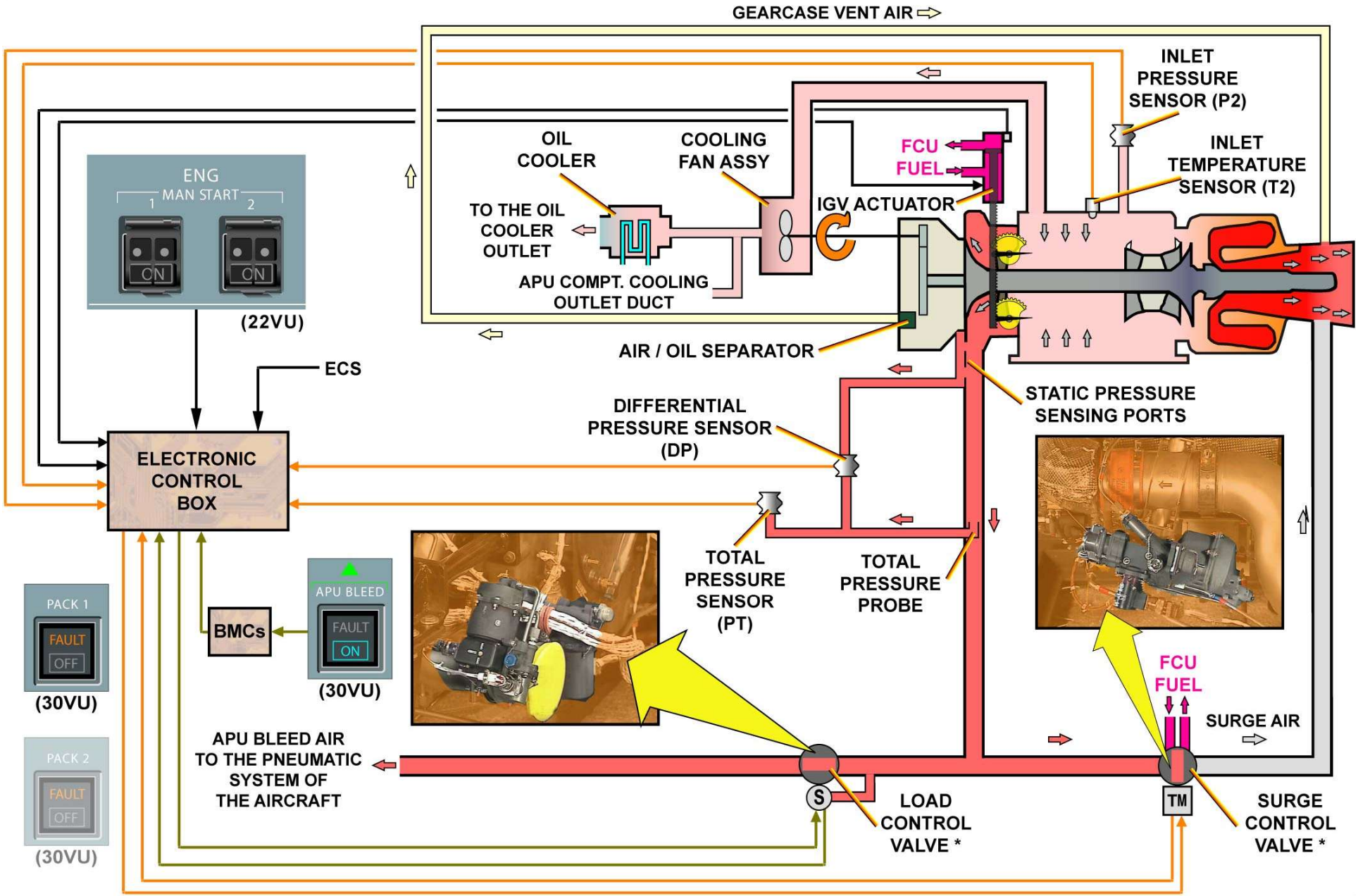
•ECB commands SCV to fully closed position

The ECB receives a demand signal from the ECS Control Computer after the Pack P/B on the Cockpit overhead panel is pushed in.

The ECB, due to this input signal, sends a retract command signal to the IGV-Actuator to drive the Inlet Guide Vanes into a more open position.

This will let more air from the APU Inlet Plenum go through the IGVs into the Load Compressor Housing.

To make sure the necessary bleed air mass flows from the APU to the ECS, the ECB commands the SCV to the fully closed position.


GEARCASE VENT AIR
INLET PRESSURE SENSOR (P2)
INLET TEMPERATURE SENSOR (T2)
OIL COOLER
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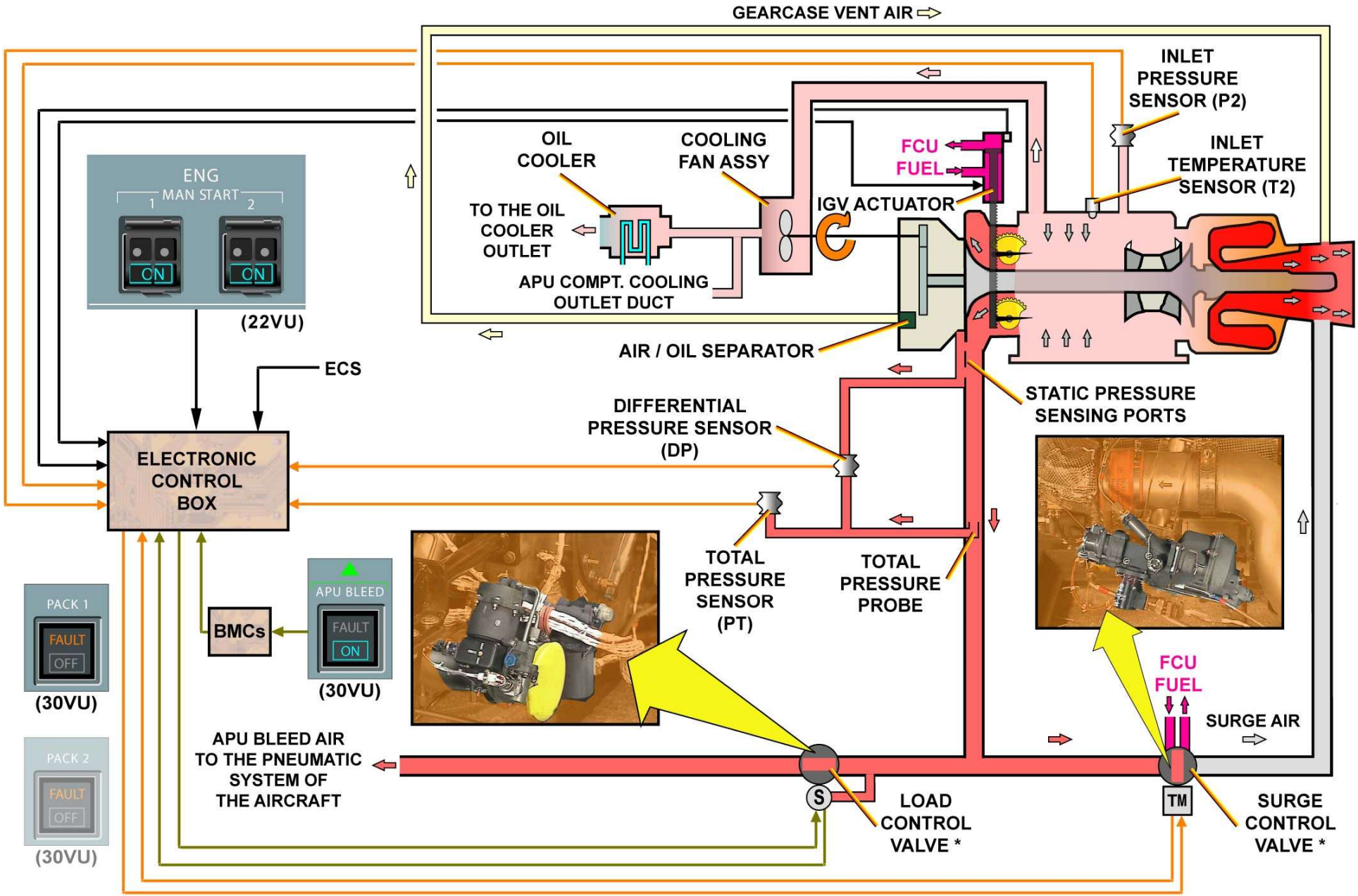
FCU FUEL
SURGE AIR
APU BLEED AIR TO THE PNEUMATIC SYSTEM OF THE AIRCRAFT
S
LOAD CONTROL VALVE *
TM
SURGE CONTROL VALVE *

APU RUNNING AT 100%

•ECB receives a MES boost signal
•ECB commands IGV actuator to MAX retracted position
•SCV receives command signal from ECB
•A the end of engine start
- MES signal no longer valid
- ECB commands IGV and SCV for bleed supply to ECS

After the Engine Master Switch is moved to the ON position, the ECB receives a Main Engine Start (MES) boost signal to increase the bleed pressure for engine start.
The ECB commands the IGV Actuator to the maximum retracted position to drive the IGVs to the fully open position.
The SCV receives the command signal from the ECB to modulate and discharge a certain mass of air into the APU exhaust.
When the engine start is completed, the MES signal is no longer valid and the ECB commands the IGV actuator and the SCV to the required position for bleed supply to the ECS.


GEARCASE VENT AIR
INLET PRESSURE SENSOR (P2)
INLET TEMPERATURE SENSOR (T2)
OIL COOLER
COOLING FAN ASSY
FCU FUEL
IGV ACTUATOR
TO THE OIL COOLER OUTLET
APU COMPT. COOLING OUTLET DUCT
AIR / OIL SEPARATOR
ENG
MAN START
1
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ON
ON
(22VU)
ECS
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DIFFERENTIAL PRESSURE SENSOR (DP)
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FCU FUEL
SURGE AIR
APU BLEED AIR TO THE PNEUMATIC SYSTEM OF THE AIRCRAFT
S
LOAD CONTROL VALVE *
TM
SURGE CONTROL VALVE *

APU System Management Description and Operation

APU START SEQUENCE

•APU system management description:

- APU start
- APU on-speed
- APU normal shutdown
- APU protective shutdown
- APU emergency shutdown

•MASTER SWitch P/B set to ON:

- ON light comes on
- ECB energized
- ECB starts power-up test
- Fuel pump energized
- Air intake flap opens

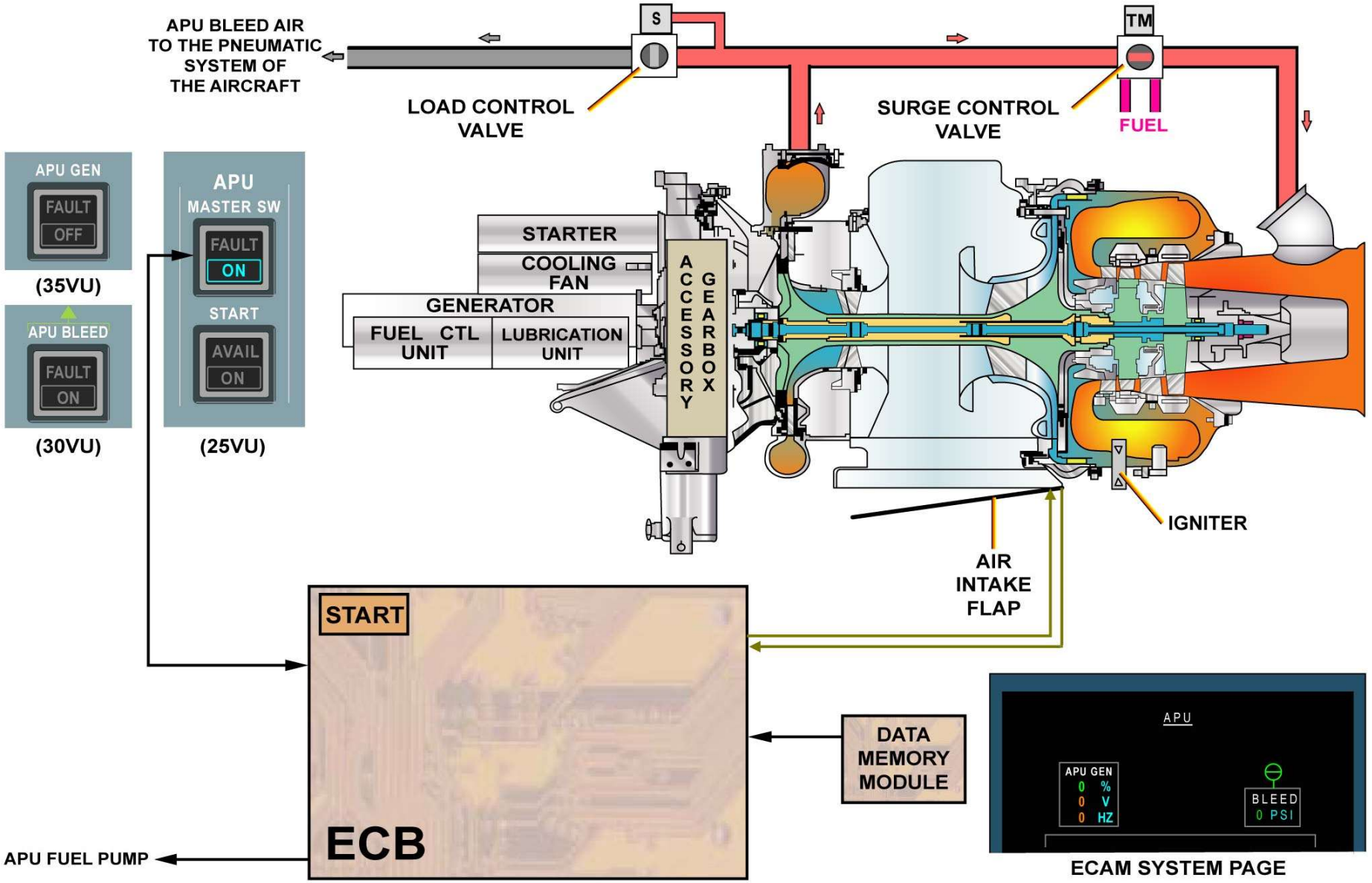
Auxiliary Power Unit (APU) normal operation, starting and shutdown, are initiated from the APU control panel but controlled and monitored by the ECB.

Following conditions will be controlled and monitored:

- APU start,
- APU on-speed,
- APU normal shutdown,
- APU protective shutdown,
- APU emergency shutdown.

When the MASTER SWitch P/B is set to ON:

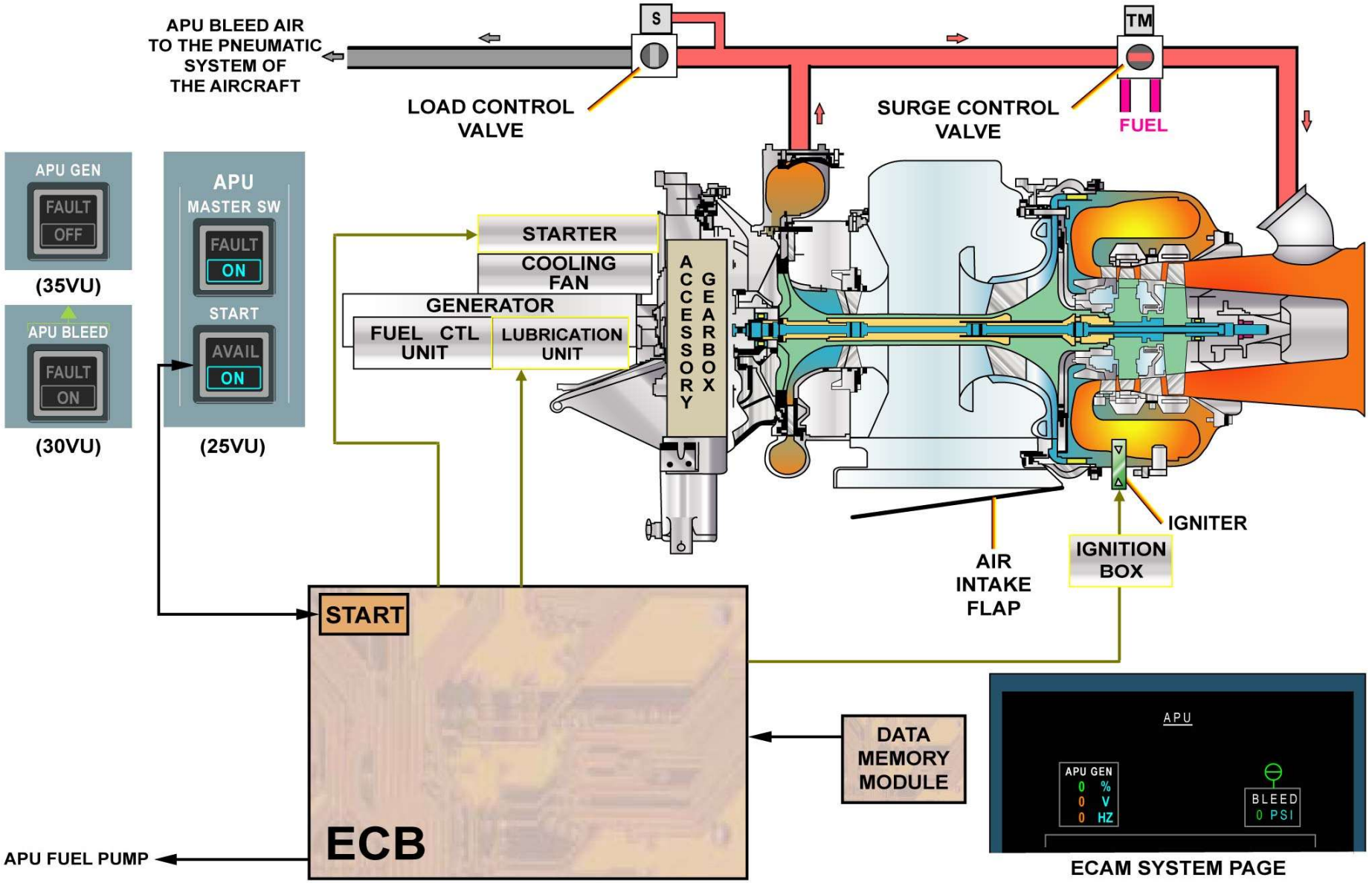
- the ON light comes on,
- the Electronic Control Box (ECB) is energized,
- the ECB starts the power-up test,
- the ECB exchanges data with the Data Memory Module,
- the APU LP valve opens,
- the APU fuel pump is energized if fuel system pressure is low,
- the APU air intake flap opens,
- the ECAM APU page comes into view.


APU BLEED AIR TO THE PNEUMATIC SYSTEM OF THE AIRCRAFT
S
TM
LOAD CONTROL VALVE
SURGE CONTROL VALVE
FUEL
APU GEN
FAULT
OFF
(35VU)
APU BLEED
FAULT
ON
(30VU)
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
(25VU)
STARTER
COOLING FAN
GENERATOR
FUEL CTL UNIT
LUBRICATION UNIT
ACCESSORY GEARBOX
IGNITER
AIR INTAKE FLAP
START
ECB
DATA MEMORY MODULE
APU FUEL PUMP
APU
APU GEN
0 %
0 V
0 HZ
BLEED
0 PSI
ECAM SYSTEM PAGE

•START P/B set to ON:

- ON legends come on
- Start contactor energized when air intake flap open, power-up test complete, data exchange between data memory module and ECB complete
- Contactors energize starter motor and causes APU main shaft to turn
- Igniter energized
- De-oil valve opens with oil/fuel temperature and altitude
- ECAM APU page comes into view

When the START P/B is set to ON:
- the ON legend comes on,
- the ECB energizes the back-up start contactor and the start contactor when these conditions are present: air intake flap open, power-up test complete, data exchange between data memory module and ECB complete,
- the contactors energize the starter motor and causes the APU main shaft to start to turn,
- the igniter is energized,
- the de-oil valve opens with the oil/fuel temperature and altitude


APU BLEED AIR TO THE PNEUMATIC SYSTEM OF THE AIRCRAFT
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LOAD CONTROL VALVE
SURGE CONTROL VALVE
FUEL
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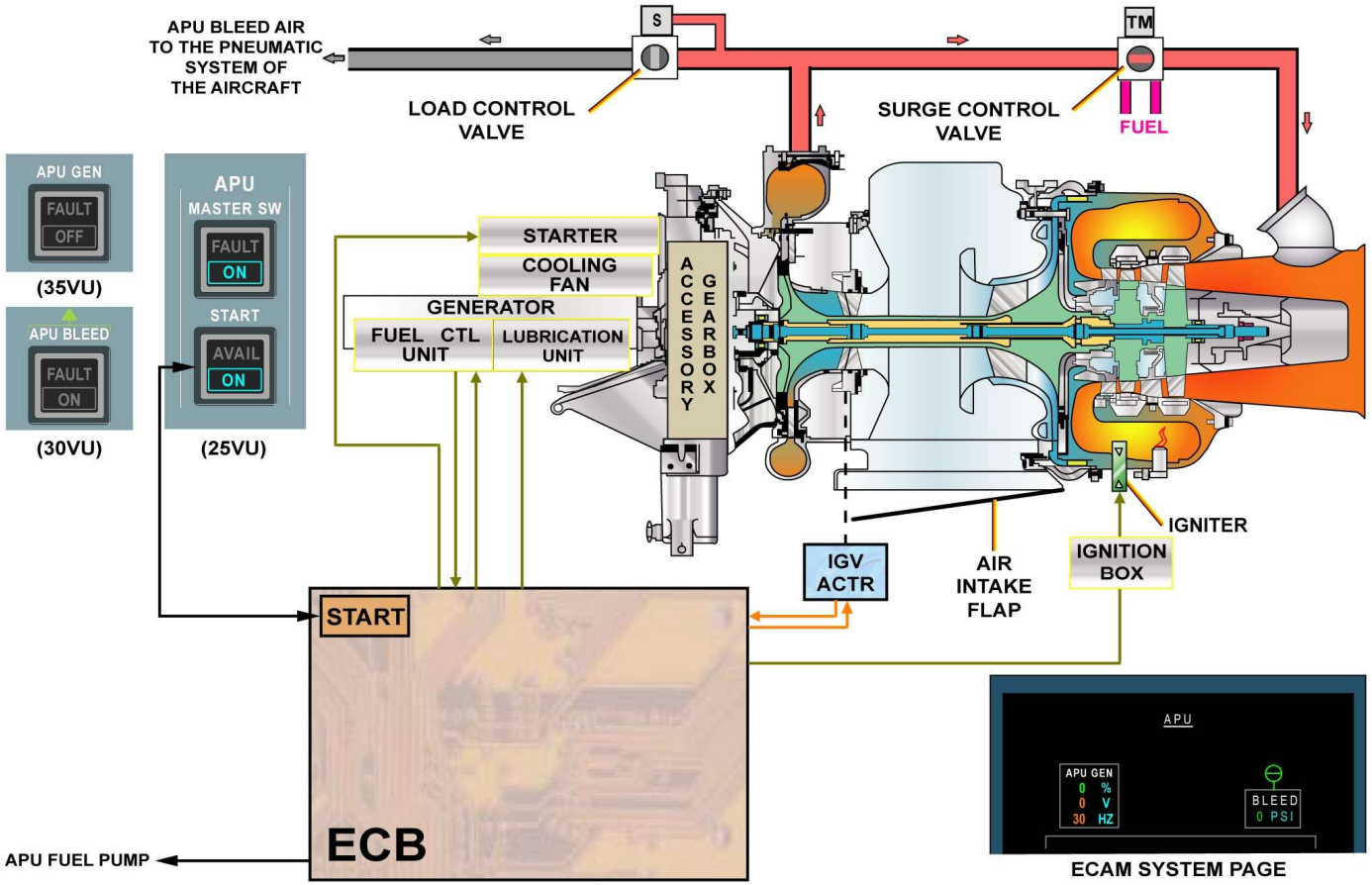
IGNITION BOX
START
ECB
DATA MEMORY MODULE
APU FUEL PUMP
APU
APU GEN
0 %
0 V
0 HZ
BLEED
0 PSI
ECAM SYSTEM PAGE

APU ACCELERATION SEQUENCE

APU AT 7% RPM

• At 7% speed:
  - • ECB opens fuel solenoid valve and combustion occurs
  - • IGVs close

At 7% speed:
- the ECB opens the fuel solenoid valve and combustion occurs,
- the Inlet Guide Vanes (IGVs) close.



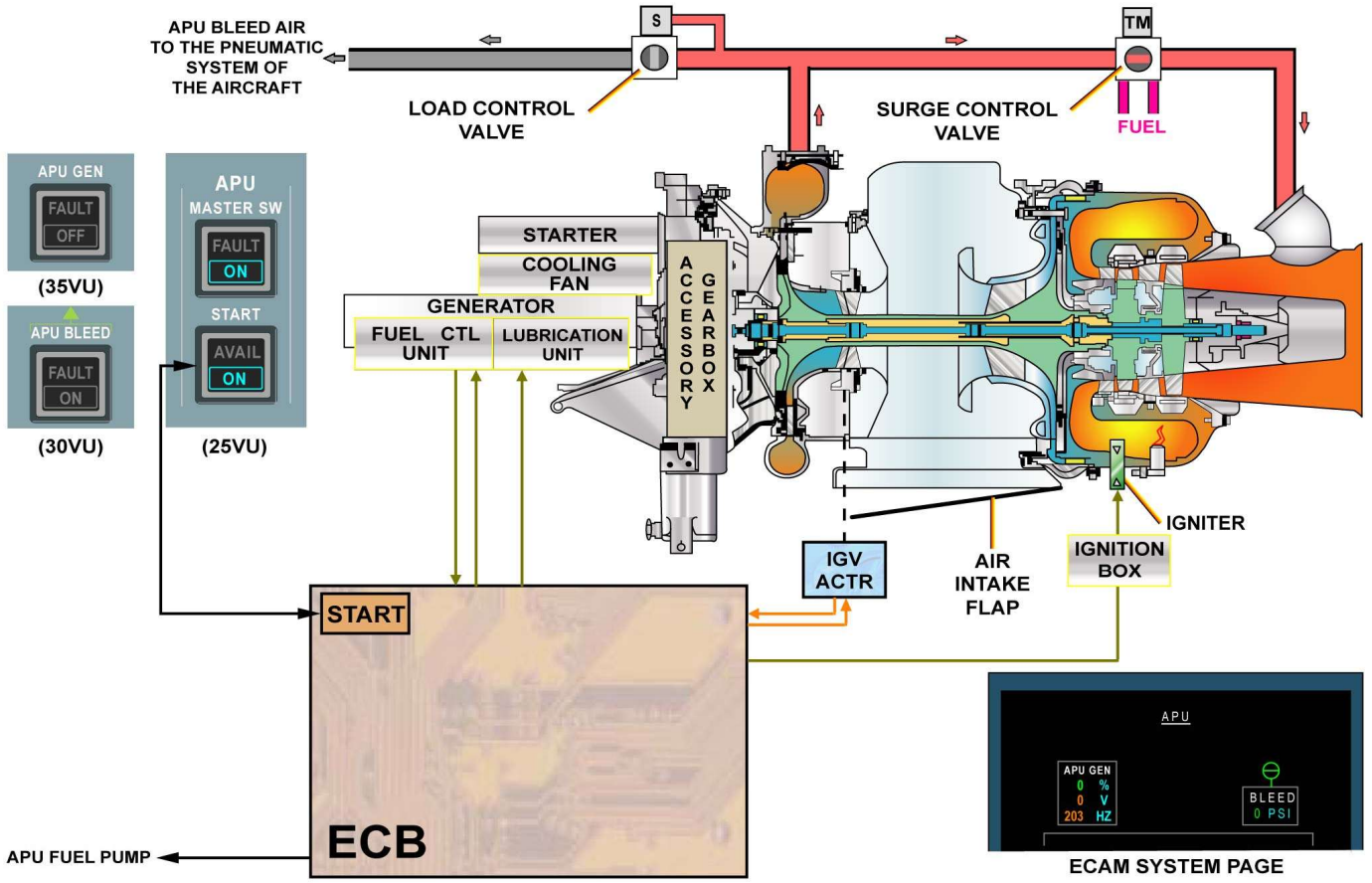
APU AT 50% RPM

•At 50% speed:

- ECB de-energizes start contactor, above 20,000 ft at 58%
- ECB de-energizes back-up start contactor

At 50% speed:

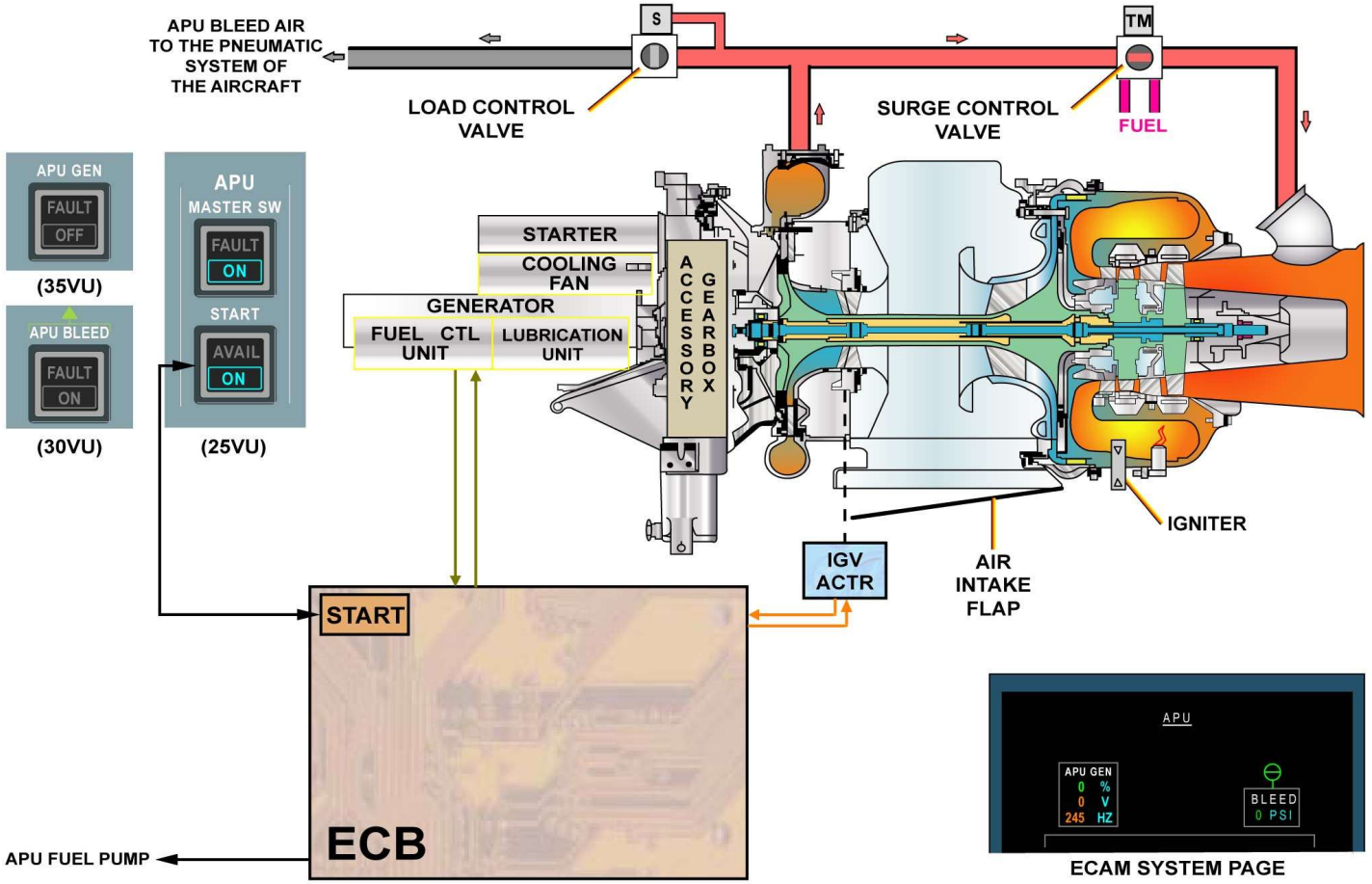
- the ECB de-energizes the start contactor, above 20,000 ft at 58%, and causes the starter motor to stop and continues to increase the speed of the APU automatically,
- the ECB de-energizes the back-up start contactor.



APU AT 60% RPM

• At 60% speed:
  - ECB de-energizes ignition unit
  - ECB de-energizes de-oil solenoid

At 60% speed:
- the ECB de-energizes the ignition unit,
- the ECB de-energizes the de-oil solenoid, if it is open.

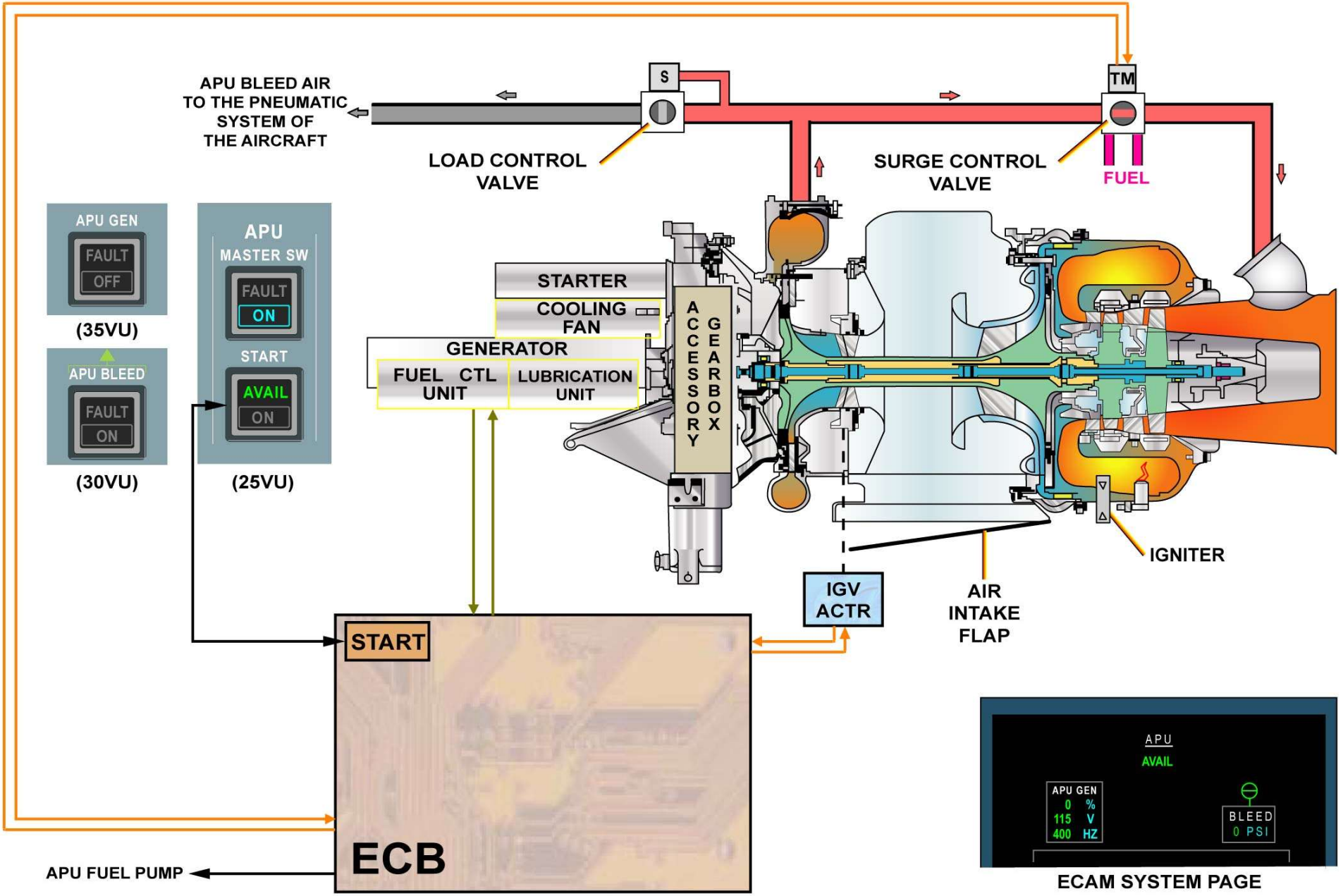


APU AT 95% RPM

•At 95% speed:

- IGVs move to 22 º
- ECB controls and monitors APU
- ON light in START P/BSW goes off
- Green AVAIL light in START P/BSW comes on
- APU generator can operate and APU bleed be switched to ON

At 95% speed:
- the IGVs move to 22 degrees' open position to prevent overheating,
- the ECB controls and monitors the APU automatically,
- the ON light in the START P/BSW goes off,
- the green AVAIL legend in the START P/BSW comes on,
- the APU generator can operate and APU bleed be switched to ON.



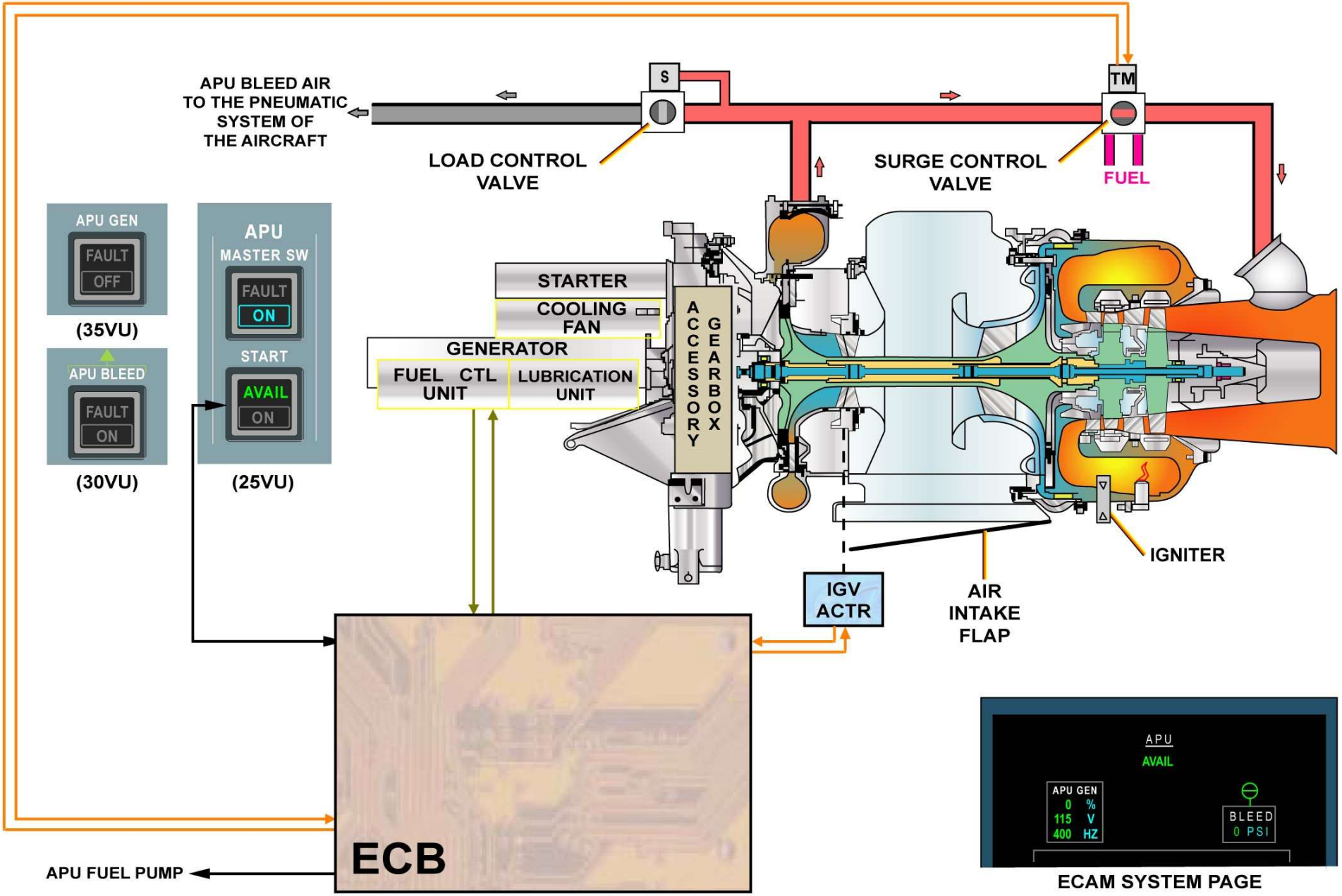
ECAM SYSTEM PAGE

APU AT 100% RPM

•At steady state speed:

- Governor loop controls fuel flow
- ECB stabilizes APU at 100%.
- If APU supplies air conditioning system, normal day & A/C on ground speed reduced to 99%.

At steady state speed, an on-speed governor loop controls the fuel flow to the APU. The ECB stabilizes the APU speed at 100%. However, if the APU supplies the air conditioning system on a normal day and while the aircraft is on the ground the speed is reduced to 99% for fuel saving reasons.



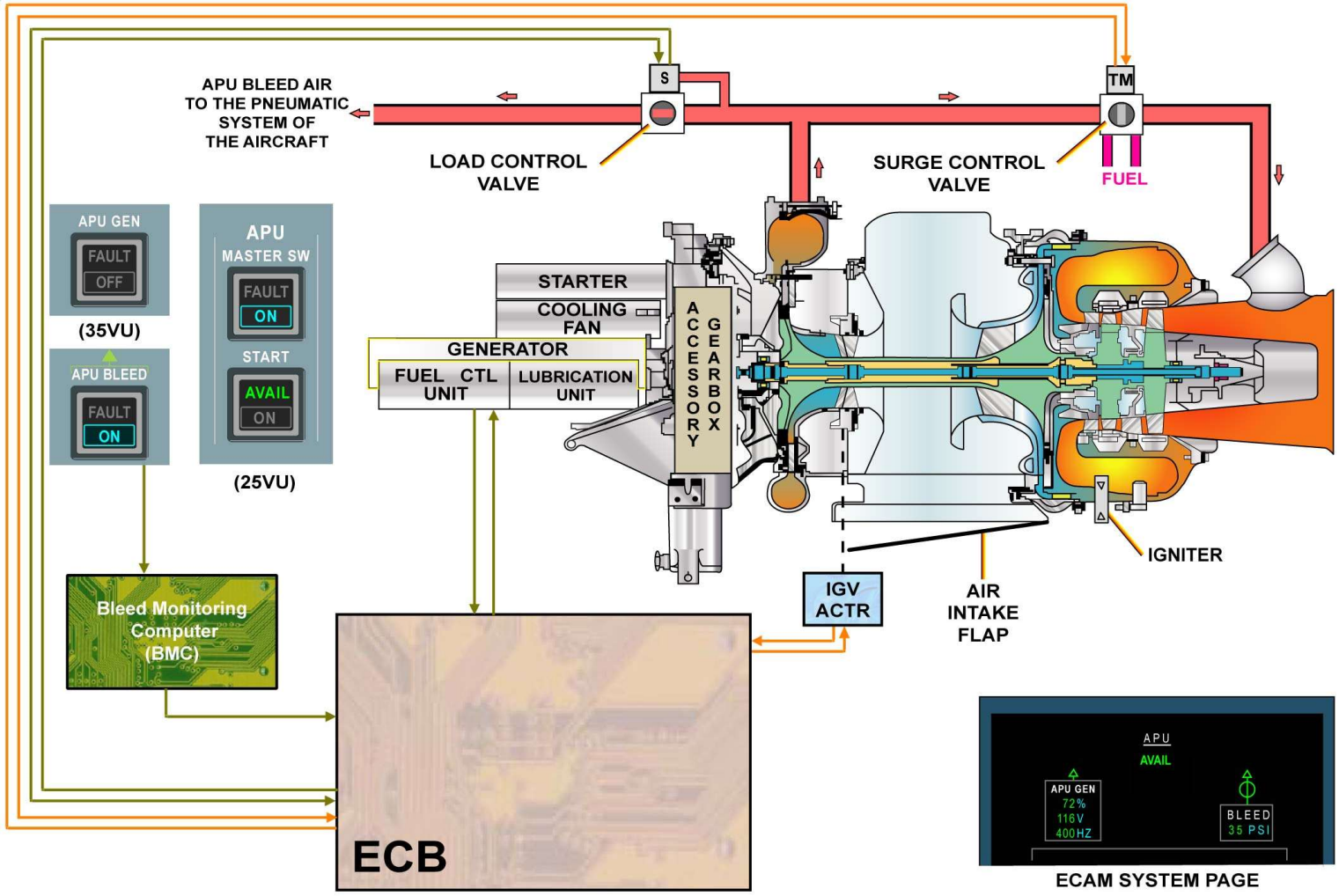
ECAM SYSTEM PAGE

APU ON-SPEED

• APU generator parameters on ECAM

•APU bleed parameters on ECAM

When the APU generator operates, the generator output parameters come into view on the ECAM system page. When the APU bleed is switched to ON, bleed parameters are displayed on the ECAM system page. The ECB opens the Load Control Valve in accordance to the Bleed Monitoring Computer (BMC) signal coming from the APU Bleed P/B.



APU NORMAL SHUTDOWN

• MASTER SW OFF:

- ECB closes IGVs (minimum position)
- Load control valve closes
- Surge control valve opens and cool-down cycle starts

When the MASTER SW is OFF, the ECB closes the IGVs to the minimum position, the load control valve closes if it is open, the surge control valve opens and the cool-down cycle of the APU starts.

• COOL-DOWN CYCLE:

- This lets the APU operate 60 seconds at low stabilized temperature
- Starts when ECB receives closed signal from load control valve
- If load control valve was not in open position, APU shuts down immediately

The cool-down cycle lets the APU operate for 60 seconds at a low stabilized temperature. It starts when the ECB receives the closed signal from the load control valve. If the load control valve was not in the open position, the APU shuts down immediately.

• OVERSPEED TEST:

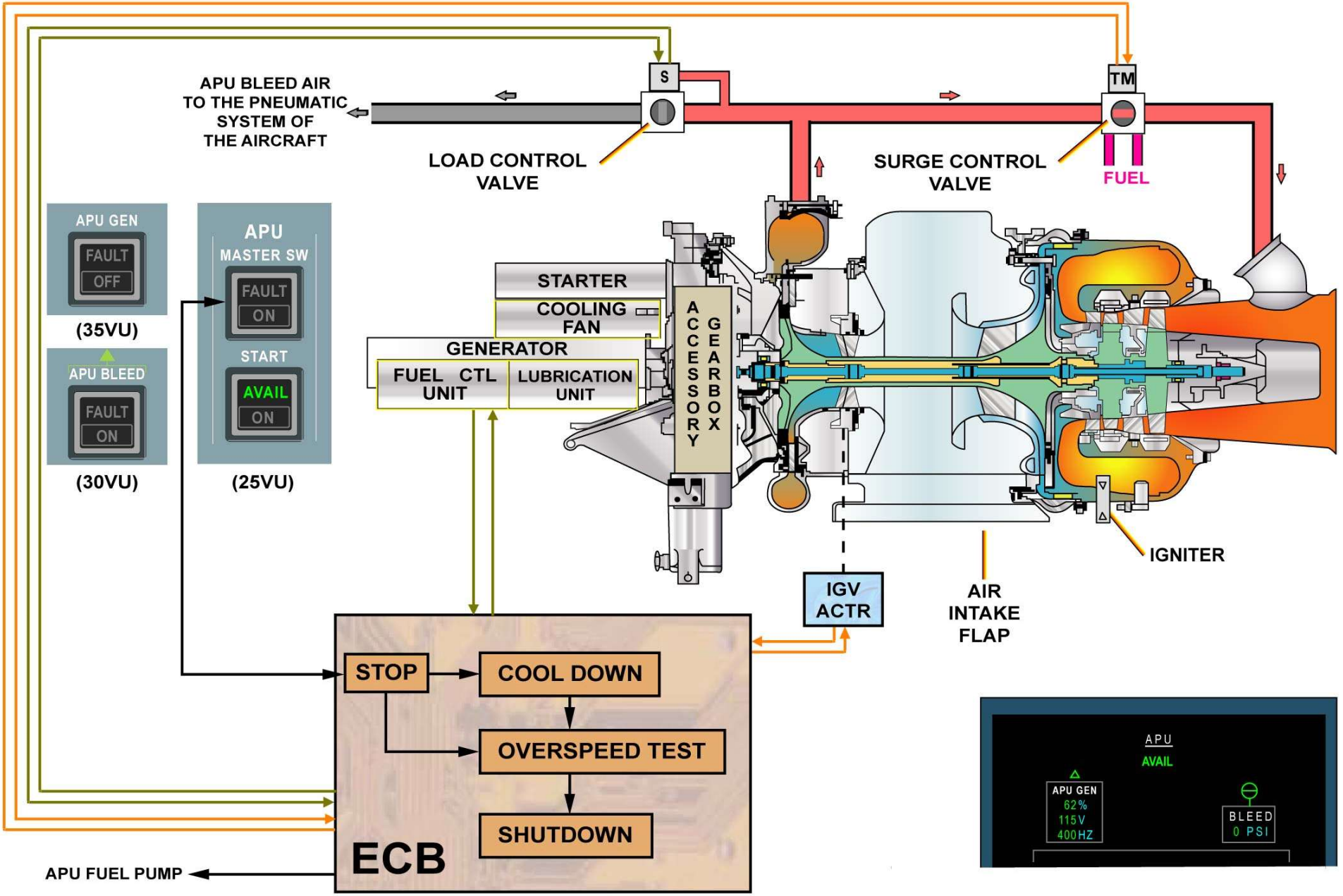
- ECB supplies signal to simulate overspeed
- 3-way shut-off solenoid in FCU close
- APU roll-down starts

During every normal shutdown the ECB tests its overspeed protection circuit by simulating an overspeed condition, which causes the 3-way shut-off solenoid in the Fuel Control Unit to close, and thereby starts the APU roll-down.

• APU ROLLDOWN:

- APU re-start command possible during shutdown
- Starter motor re-engagement not above 7% APU speed

It is possible to command an APU re-start during the shutdown sequence. APU speed must be below 7% before the starter motor is re-engaged.


APU BLEED AIR
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ON
(30VU)
APU
MASTER SW
FAULT
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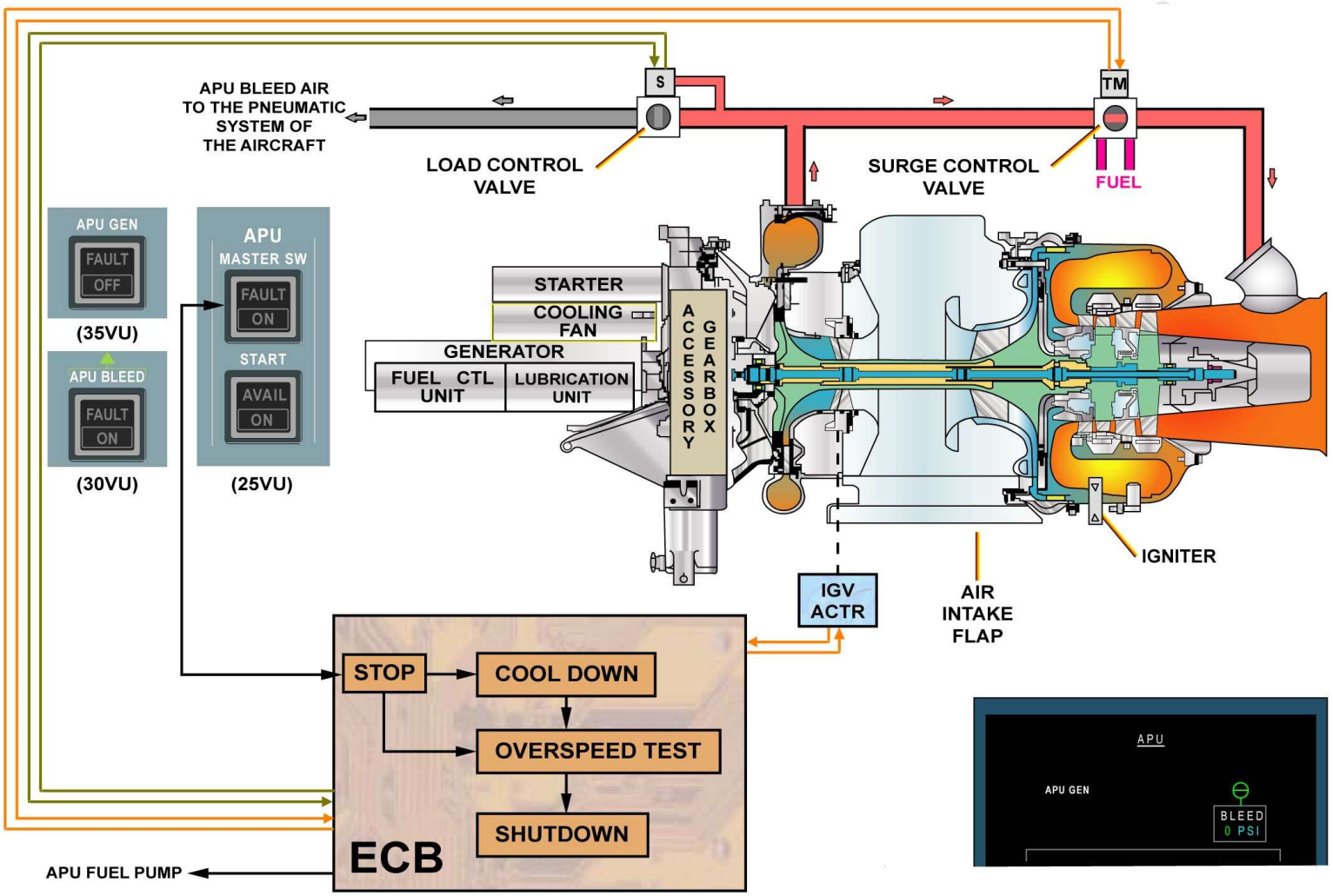
START
AVAIL
ON
(25VU)
STARTER
COOLING
FAN
GENERATOR
FUEL CTL
UNIT
LUBRICATION
UNIT
ACCESSORY GEARBOX
IGNITER
IGV
ACTR
AIR
INTAKE
FLAP
STOP
COOL DOWN
OVERSPEED TEST
SHUTDOWN
ECB
APU FUEL PUMP
APU
AVAIL
APU GEN
62%
115V
400HZ
BLEED
0 PSI

APU AT 95% RPM

• At 95% speed

•"AVAIL" light out

At 95% speed, APU "AVAIL" lights go off.

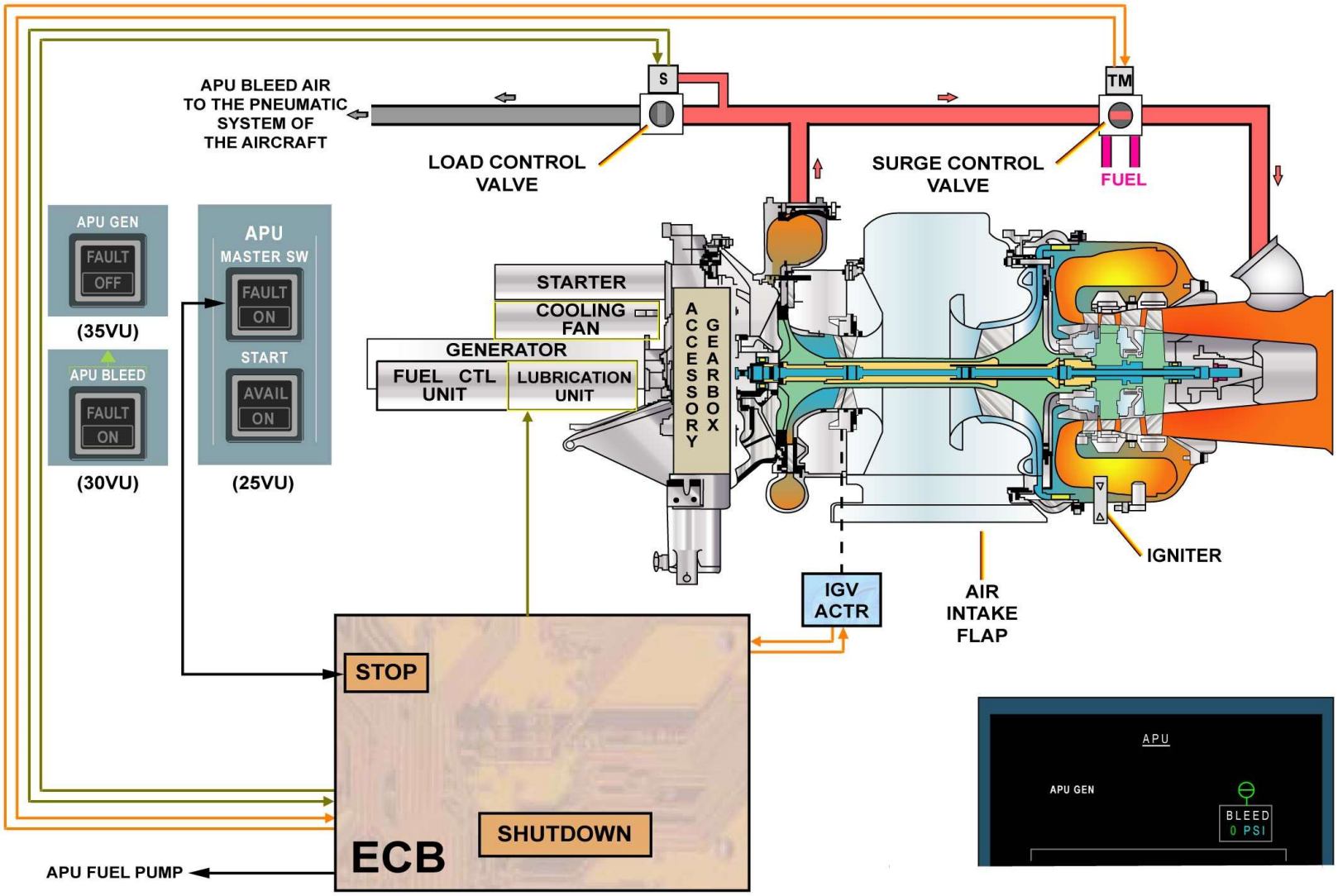


APU AT 50% RPM

•At 50% speed

•De-oil solenoid valve opens to decrease drag during next start

At 50% speed, the de-oil solenoid valve opens to decrease drag during the next start.



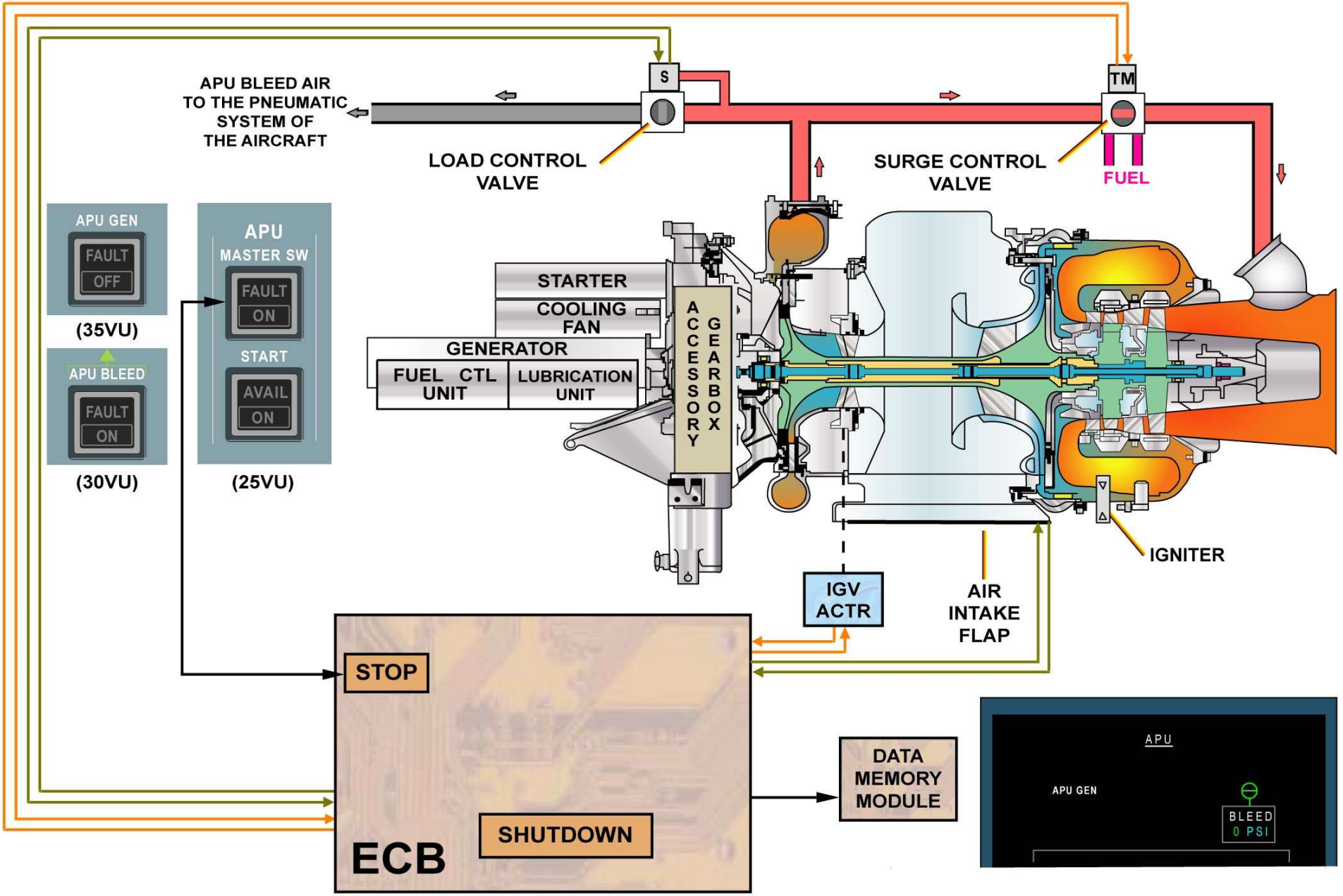
APU BELOW 7% RPM

• At and below 7% speed:
  - De-oil solenoid closes
  - APU fuel LP valve closes
  - Data memory module updated
  - Air intake closes

•ECB de-energizes itself when air intake has reached fully closed position

At and below 7% speed:
- the de-oil solenoid closes,
- the APU fuel LP valve closes,
- the data memory module is updated,
- the air intake closes.

The ECB de-energizes itself when the air intake has reached the fully closed position.


APU BLEED AIR
TO THE PNEUMATIC
SYSTEM OF
THE AIRCRAFT
S
TM
LOAD CONTROL
VALVE
SURGE CONTROL
VALVE
FUEL
APU GEN
FAULT
OFF
(35VU)
APU BLEED
FAULT
ON
(30VU)
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
(25VU)
STARTER
COOLING
FAN
GENERATOR
FUEL CTL
UNIT
LUBRICATION
UNIT
ACCESSORY GEARBOX
IGNITER
IGV
ACTR
AIR
INTAKE
FLAP
STOP
ECB
SHUTDOWN
DATA
MEMORY
MODULE
APU
APU GEN
BLEED
0 PSI

APU PROTECTIVE SHUTDOWN

• ECB protective shutdown conditions:

- Overspeed
- ECB failure
- Underspeed
- Overtemperature
- Loss of speed
- Sensor failure
- No flame
- Flap not open
- High oil temperature
- Low oil pressure
- No speed
- Inlet overheat
- No acceleration
- Clogged oil filter
- Main power interrupt

When the ECB is energized, it controls the APU starting and operating phases. If an abnormal parameter is found, it starts an immediate shutdown without time delay, even if the APU bleed air is in use.

The ECB protective shutdown parameters are:

- overspeed,
- ECB failure,
- underspeed,
- overtemperature,
- loss of speed,
- sensor failure: thermocouples, low oil level and Low Oil Pressure (LOP) switch failure,
- no flame,
- flap not open,
- High Oil Temperature (HOT),
- LOP,
- no speed,
- inlet overheat,
- no acceleration,
- clogged oil filter,
- main power stop.

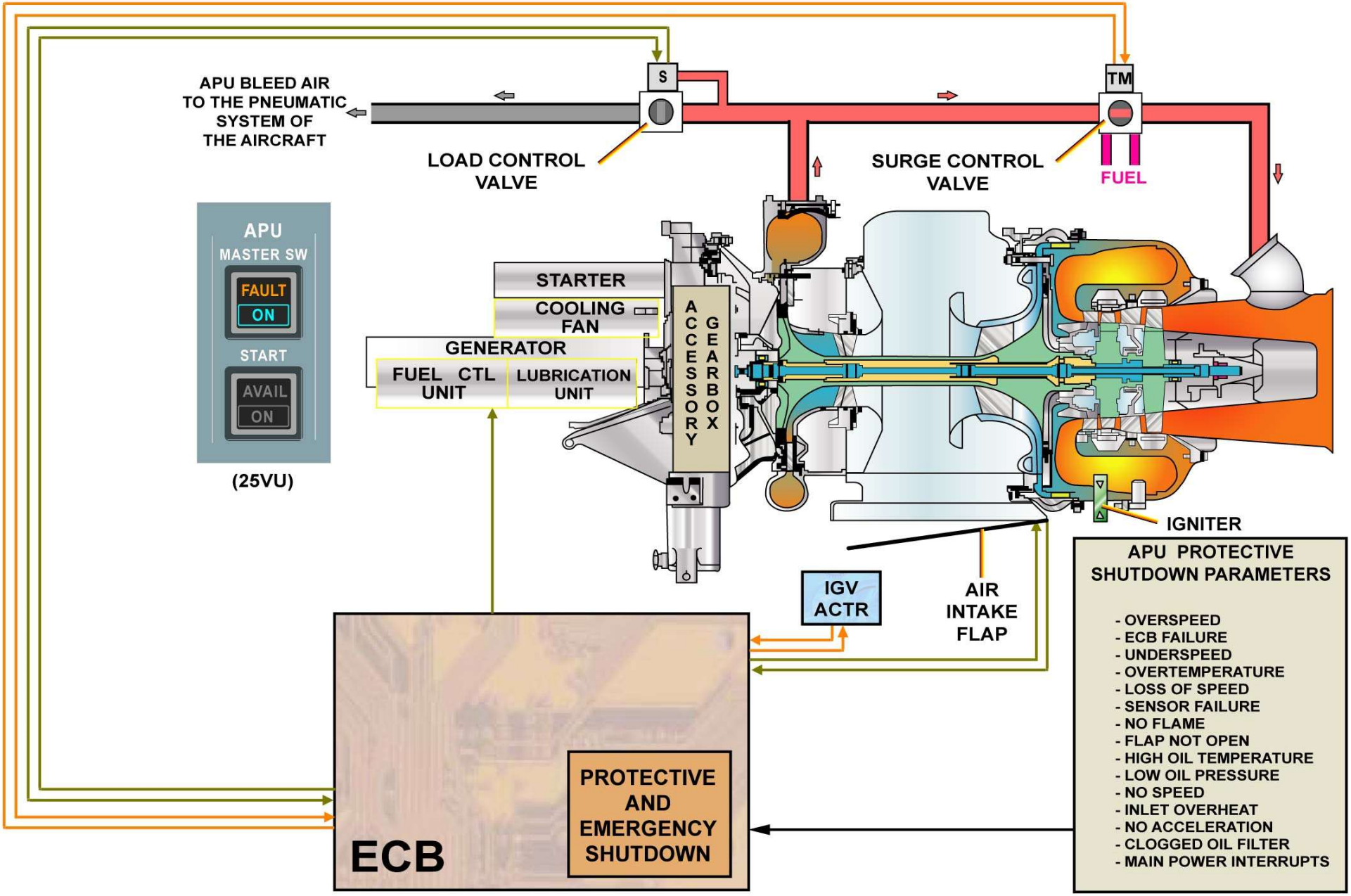
APU EMERGENCY SHUTDOWN

•APU FIRE P/B

•APU SHUT OFF P/B

The ECB starts an emergency shutdown when the APU FIRE P/B, in the cockpit, is released out or when the APU SHUT OFF P/B, on the external power receptacle panel, is pushed.

The ECB starts an automatic emergency shutdown when an APU fire is found on ground. The APU stops immediately without time delay, even if the APU bleed air system is in use.


APU BLEED AIR TO THE PNEUMATIC SYSTEM OF THE AIRCRAFT
S
TM
LOAD CONTROL VALVE
SURGE CONTROL VALVE
FUEL
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
(25VU)
STARTER
COOLING FAN
GENERATOR
FUEL CTL UNIT
LUBRICATION UNIT
ACCESSORY GEARBOX
IGNITER
IGV ACTR
AIR INTAKE FLAP
APU PROTECTIVE SHUTDOWN PARAMETERS
- OVERSPEED
- ECB FAILURE
- UNDERSPEED
- OVERTEMPERATURE
- LOSS OF SPEED
- SENSOR FAILURE
- NO FLAME
- FLAP NOT OPEN
- HIGH OIL TEMPERATURE
- LOW OIL PRESSURE
- NO SPEED
- INLET OVERHEAT
- NO ACCELERATION
- CLOGGED OIL FILTER
- MAIN POWER INTERRUPTS
ECB
PROTECTIVE AND EMERGENCY SHUTDOWN

ECB Interfaces

POWER SUPPLY
• APU MAIN control relay
•A/C batteries
•A/C DC network
One of the A/C batteries at the minimum and the A/C DC network, electrically supply the Electronic Control Box (ECB), through the MAIN control relay of the Auxiliary Power Unit (APU).

MASTER SWITCH P/B
• Supply or stop signal to ECB
•FAULT light when automatic or emergency shutdown occurs
The APU MASTER SWITCH sends a discrete supply or stop signal to the ECB. The ECB sends a discrete signal to the FAULT light, when an automatic shutdown occurs or if there is an emergency shutdown.

AIR INTAKE FLAP
• ECB receives and sends opening or closing signal
The ECB receives an air intake flap open or closed position signal and sends a power output to open or close the air intake flap.

START P/B
• Starting sequences
•ON light
•AVAIL light speed above 95%
A discrete input signal from the START P/B starts the starting sequences. The ECB sends a discrete signal to the ON light during the APU start sequence. A discrete output signal to the A/C energizes the AVAIL light in the START P/B when the APU speed is above 95%.

BACK-UP AND MAIN START CONTACTORS
• ECB receives input from main contactor and sends outputs to back-up and start contactors
The ECB receives a discrete input from the main start contactor and sends discrete outputs to the back-up and main start contactors.

EMERGENCY STOP
• APU emergency shutdown after ECB receives signal input
A discrete input signal from the A/C starts the APU emergency shutdown logic after the ECB receives this signal.

LGCIU 1
• LGCIU sends aircraft on ground signal to ECB
The ECB receives the aircraft on ground discrete input signal from Landing Gear Control and Interface Unit (LGCIU) 1.

APU FUEL FEED SYSTEM
• Signal from APU low fuel pressure switch
•Signal to APU fuel LP shut-off valve
The ECB receives a discrete signal from the APU low fuel pressure switch. It sends a discrete signal to the APU fuel LP shut-off valve.

EIU
• MES signal from EIUs
•IGVs to fully open and bleed control valve to modulate in delivery position
During engine starts, the ECB receives a Main Engine Start (MES) signal from Engine Interface Unit (EIU) 1 or 2. This signal causes the ECB to set the Inlet Guide Vanes (IGVs) to the fully open position if APU bleed has been selected to ON.

BMC
• APU BLEED P/B to ON, BMCs send signal to ECB, controls APU load control valve open
•The BMCs receive APU load control valve closed signal to monitor pneumatic system and show ECAM indications
When the APU BLEED P/B is set to ON, Bleed Monitoring Computer (BMC) 1 or 2 sends a discrete input to the ECB. This controls the APU load control valve to open. The BMCs receive a closed-position signal from the APU load control valve to monitor the pneumatic system and to show ECAM indications.

TSO/JAR

• Technical Standard Order (TSO)/Joint Aviation Requirement (JAR) configuration programming pin

•ECB obeys TSO/JAR

The ECB receives a discrete input from the TSO/JAR configuration-programming pin. This open or ground signal finds if the ECB obeys the Technical Standard Order (TSO) or the Joint Aviation Requirements (JAR). Concerning the JAR, all System Display (S/D) circuits are available in flight. This configuration is the standard configuration. For TSO, only emergency, overspeed and loss of speed shutdowns, are available in flight.

ENVIRONMENTAL CONTROL SYSTEM (ECS)

• ECB receives ECS demand data from ACSC

•ECB sends load control valve open signal to ACSC

The ECB receives, via an ARINC 429 bus, an input from the Air Conditioning System Controller 1 and 2 (ACSC) to control the IGVs position according to the demand. The ECB sends a discrete output to the ACSC 1 and 2 to signal that the APU bleed valve is en delivery position.

A320/A321 IDENTIFICATION

• PIN identifies applications A320, A321

The ECB receives a discrete input from the A/C signature PIN PROGramming. This identification pin lets the ECB identify A321 applications for functional differences from those of an A320.

SDAC

• Indications to show on ECAM and shutdown information related warnings

The ECB sends to System Data Acquisition Concentrators (SDACs) 1 and 2, through ARINC 429 Data buses, the indications to show on the ECAM APU page and shutdown information to start the related warnings.

CFDS

• Connects to ECB

The ECB is a BITE system type-1 computer and connects to the Centralized Fault Display System (CFDS) through ARINC 429 data buses.

DMU PART

• Keeps APU lifetime data

•Monitors engine conditions

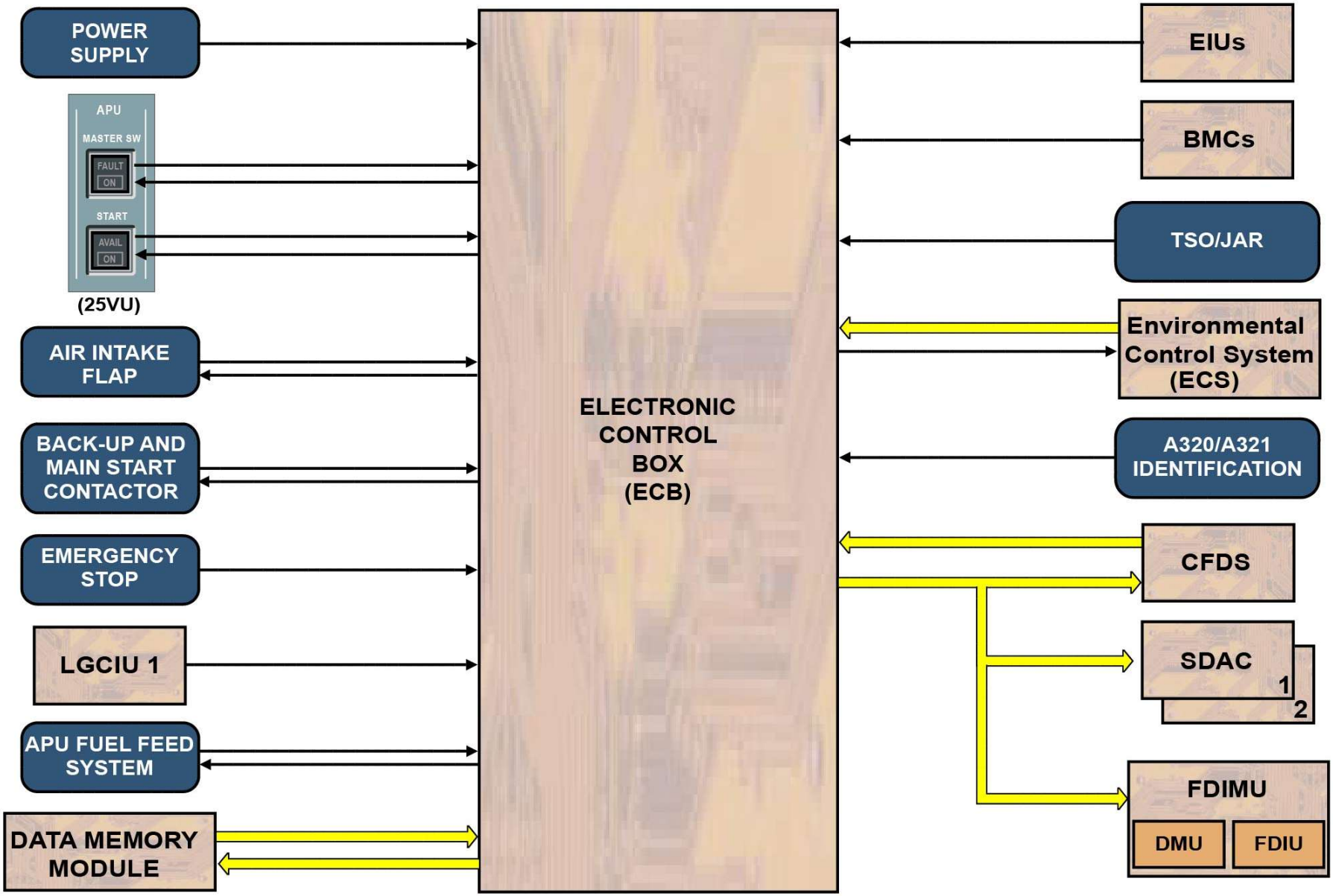
The Data Management Unit (DMU) part of the Flight Data Interface and Management Unit (FDIMU) partially keeps APU lifetime data. This information lets you monitor the engine conditions.

DATA MEMORY MODULE

• Many parameters interchanged with ECB

A data memory module installed on the APU inlet plenum keeps and interchanges many parameters with the ECB:

- APU serial number,
- APU operating hours and starts,
- APU accumulated hot time,
- APU accumulated shutdowns, etc.


POWER SUPPLY
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
(25VU)
AIR INTAKE FLAP
BACK-UP AND MAIN START CONTACTOR
EMERGENCY STOP
LGCIU 1
APU FUEL FEED SYSTEM
DATA MEMORY MODULE
ELECTRONIC CONTROL BOX (ECB)
EIUs
BMCs
TSO/JAR
Environmental Control System (ECS)
A320/A321 IDENTIFICATION
CFDS
SDAC
1
2
FDIMU
DMU
FDIU

APU Drain System Presentation

APU DRAIN SYSTEM

• Prevention of collection of fluids in the APU system and compartment

A drain system prevents the collection of fluids in the Auxiliary Power Unit (APU) system and compartment.

FCU / OIL PUMP SEAL DRAIN

• Collector line to the drain tank: Fuel or oil leaks

The Fuel Control Unit (FCU) / oil pump seal drain line is routed via a collector line to the drain tank. This line drains fuel or oil leaks.

BLEED CONTROL VALVE ACTUATOR SEAL DRAIN

• Collector line to the drain tank: Fuel leaks only

The bleed control valve actuator seal drain line is routed via a collector line to the drain tank. This line drains fuel leaks only.

INLET GUIDE VANE ACTUATOR SEAL DRAIN

• Collector line to the drain tank: Fuel leaks only

The Inlet Guide Vane (IGV) actuator drain line is routed via a collector line to the drain tank. This line drains fuel leaks only.

FRONT BEARING SEAL DRAIN

• Oil leak flows to the A/C drain mast

Any oil leak from the front bearing seal flows to the A/C drain mast.

START FUEL MANIFOLD PURGE

• Purged to the APU exhaust

The fuel, which remains in the pilot injectors and manifold, is purged to the APU exhaust.

AIR BYPASS PLENUM DRAIN

• Drain line is routed alone to the drain mast:
    - Fuel or air leaks

The air bypass plenum drain line is routed to the drain mast. This drain line collects fuel, water or air leaks.

EXHAUST MUFFLER DRAIN

• Drain line is routed to the drain mast: Fuel, water or air leaks

The exhaust muffler drain line is routed to the drain mast. This drain line collects fuel, water or air leaks.

COMBUSTOR HOUSING DRAIN

• Drain line is routed to the drain mast

The combustion housing drain line is routed to the drain mast. This drain line collects unburned fuel from the combustion chamber that may be accumulated in the combustor following an unsuccessful light-up.

DRAIN TANK

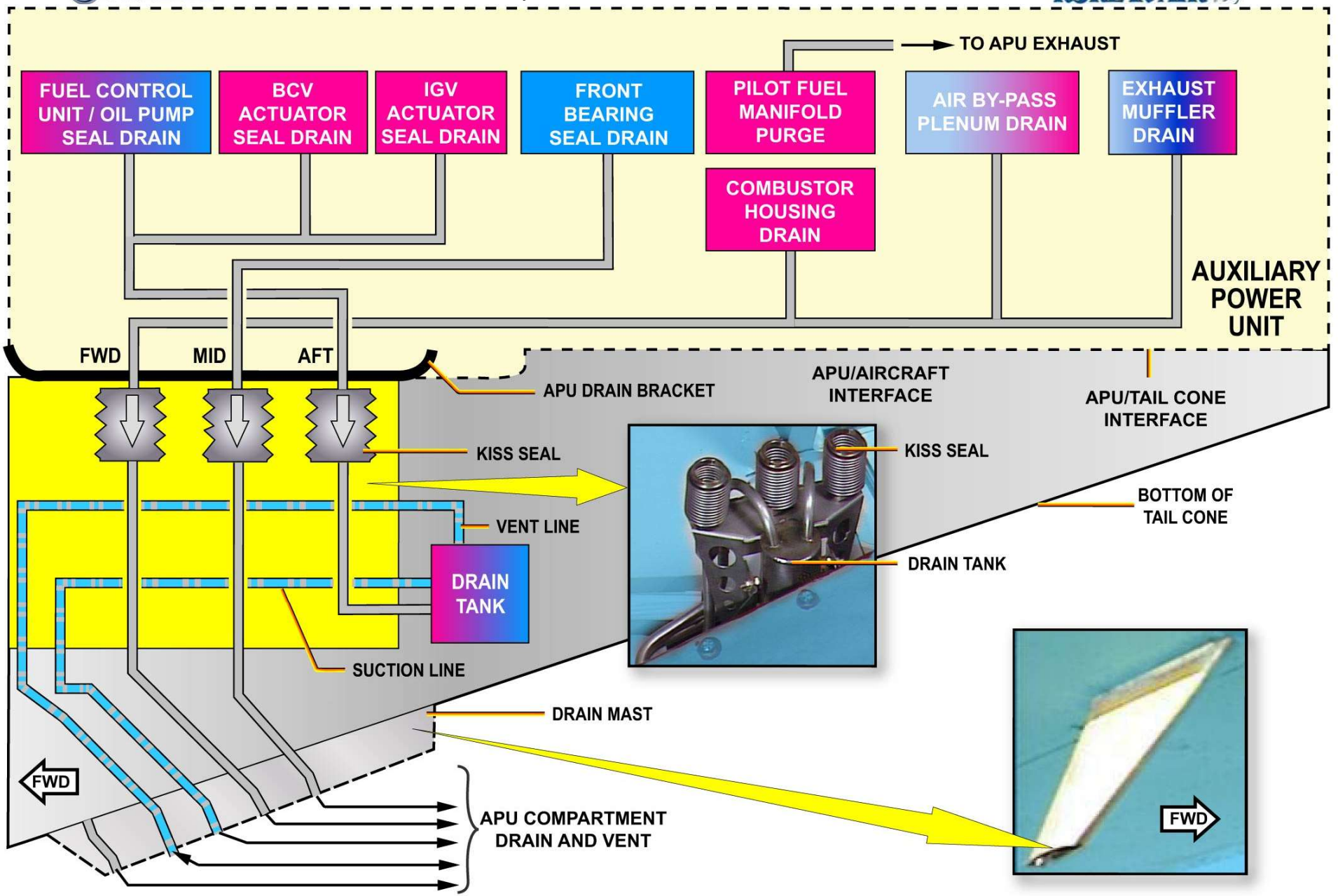
• Connected to the drain mast

•Airflow across the drain mast, vacuum in the drain line: Suction effect produced at 200 kts

•Vent line ventilates the drain tank and drain lines

•APU drain lines:
    - Right access door
    - Kiss seals

For venting and evacuation the drain tank is connected to the drain mast. Airflow across the drain mast creates a vacuum in the drain line. The suction effect produced at 200 kts, is sufficient to remove the contents of the drain tank. A vent line ventilates the drain tank and drain lines. The APU drain lines are connected to the right access door drain lines through spring adapter kiss seals


TO APU EXHAUST
FUEL CONTROL UNIT / OIL PUMP SEAL DRAIN
BCV ACTUATOR SEAL DRAIN
IGV ACTUATOR SEAL DRAIN
FRONT BEARING SEAL DRAIN
PILOT FUEL MANIFOLD PURGE
COMBUSTOR HOUSING DRAIN
AIR BY-PASS PLENUM DRAIN
EXHAUST MUFFLER DRAIN
AUXILIARY POWER UNIT
FWD
MID
AFT
APU DRAIN BRACKET
APU/AIRCRAFT INTERFACE
APU/TAIL CONE INTERFACE
KISS SEAL
KISS SEAL
VENT LINE
BOTTOM OF TAIL CONE
DRAIN TANK
DRAIN TANK
SUCTION LINE
DRAIN MAST
FWD
APU COMPARTMENT DRAIN AND VENT
FWD

APU Basic Description

GENERAL

• APU in tail cone

•Tie rods attach APU to structure by a three-point mounted suspension system

•A pair of access doors allow to lift or lower the APU

The Auxiliary Power Unit (APU) is installed in the fuselage tail cone. Tie rods attach the unit by a three-point mounted suspension system to the structure brackets on the compartment ceiling in a fireproof compartment. A pair of access doors on the bottom of the tail cone opens outwards to let the APU be lifted and lowered.

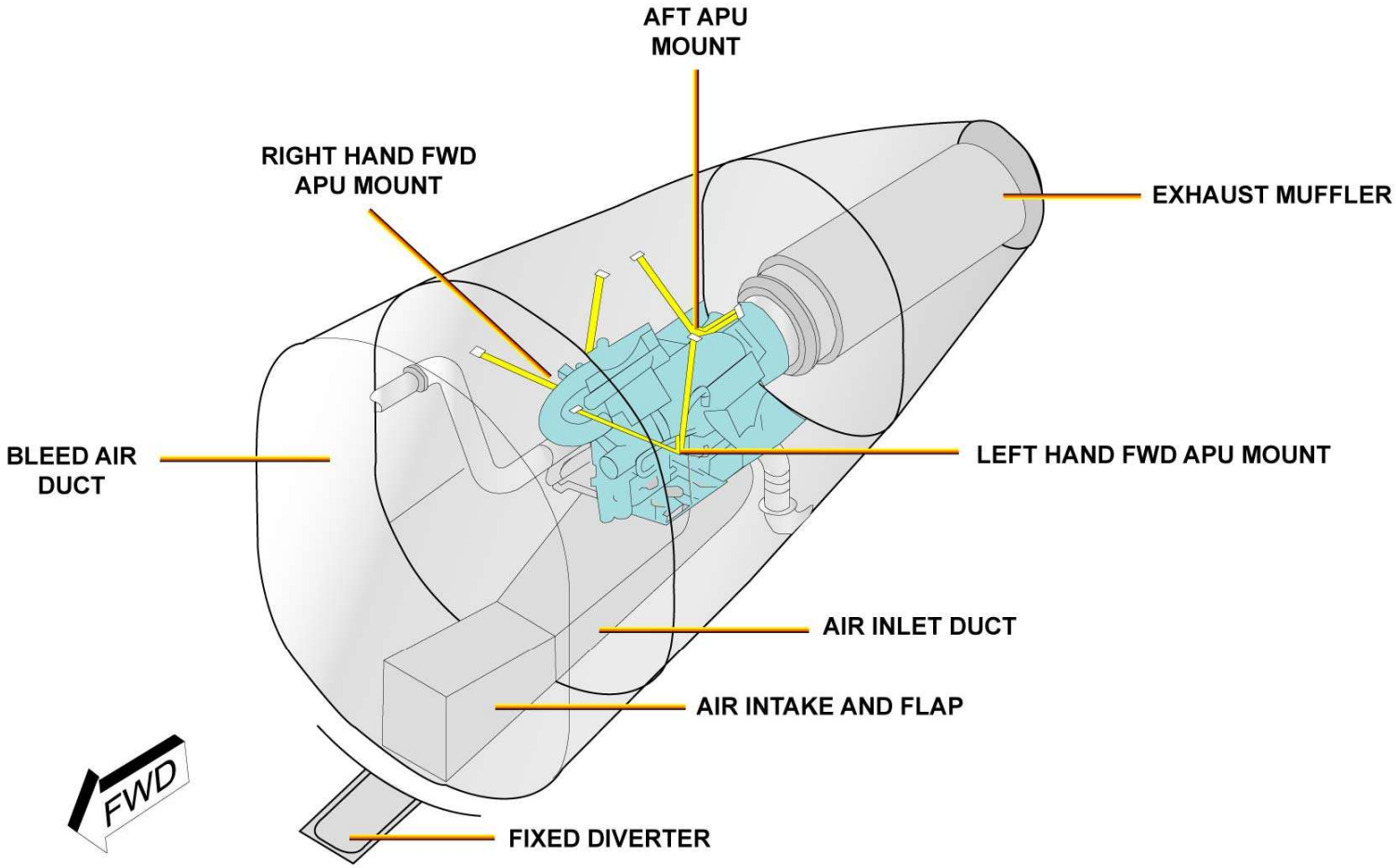
AIR INTAKE SYSTEM

• Ducts ambient air to the APU inlet

•Fixed diverter, inlet flap, inlet duct

The air intake system ducts ambient air to the APU inlet plenum. The air intake system includes:

- a fixed diverter that increases ram air recovery for flight operation and also prevents any fluids, flowing along the fuselage, from entering the air intake,
- an air intake with inlet flap,
- an air inlet duct.


AFT APU MOUNT
RIGHT HAND FWD APU MOUNT
EXHAUST MUFFLER
BLEED AIR DUCT
LEFT HAND FWD APU MOUNT
AIR INLET DUCT
AIR INTAKE AND FLAP
FWD
FIXED DIVERTER

ENGINE CONTROLS

• ECB controls and monitors the APU operation

•FADEC

•ECB functions

The Electronic Control Box (ECB) controls and monitors the APU operation. It is a Full Authority Digital Engine Control (FADEC) type computer. The ECB has the following functions:

- control of the APU start sequence,
- monitoring of the APU speed, exhaust gas temperature and bleed air supply,
- normal stop sequence and automatic or emergency shutdown,
- failure indication for trouble shooting.

ENGINE

• Single spool

•Single stage centrifugal compressor, reverse flow combustion chamber, two-stage axial flow turbine

The APU is a single spool engine based on a modular design including a power section, driving a single stage centrifugal load compressor and an accessory gearbox. The APU power section has:

- a single stage centrifugal compressor,
- a reverse flow combustion chamber,
- a two-stage axial flow turbine.

IGV

• Controls the amount of air discharged from the APU load compressor

•Controlled by ECB

•24 IGVs operated by a fuel servo valve actuator

The Inlet Guide Vanes (IGVs) control the amount of air discharged from the APU load compressor. The 24 IGVs are moved simultaneously by a gear train operated by an actuator. The IGV system uses fuel as hydraulic fluid for the servo valve actuator to control the IGVs through the ECB.

BLEED AND SURGE AIR

• Provides air to the A/C pneumatic system, avoids load compressor surge

•Bleed Control Valve, electrically controlled and fuel operated

The bleed and surge air system supplies air to the A/C pneumatic system while avoiding load compressor surge. The bleed control valve acts as a combined bleed and surge valve, electrically controlled by the ECB and fuel operated.

OIL SYSTEM

• Electrical generator, accessory gearbox, APU bearings cooled and lubricated

•Components located on the gearbox, oil cooler located on the APU left hand side

A wet sump lubrication system cools and lubricates the electrical generator, the accessory gearbox and the APU bearings. The system components are all located on the gearbox except the oil cooler that is located on the APU left hand side.

IGNITION AND STARTING SYSTEM

• Rotates the engine to a self sustained speed

•Starts ignition of the fuel/air mixture

•An electrical starter motor, an ignition unit, two igniter plugs

The ignition and starting system rotates the engine to a self-sustained speed. It also will start ignition of the fuel/air mixture in the engine combustion chamber. The system includes:

- an electrical starter motor,
- an ignition unit,
- two igniter plugs.

ACCESSORY GEARBOX

• Transmits the shaft power to the APU accessories and to the APU generator

•Oil reservoir

•Starter motor assembly, cooling air fan with PMG

The gearbox transmits the shaft power to the APU accessories and to the APU generator, which are installed on the gearbox pads. The gearbox is also the oil reservoir for the APU lubrication system. The components mounted on the accessory gearbox are:

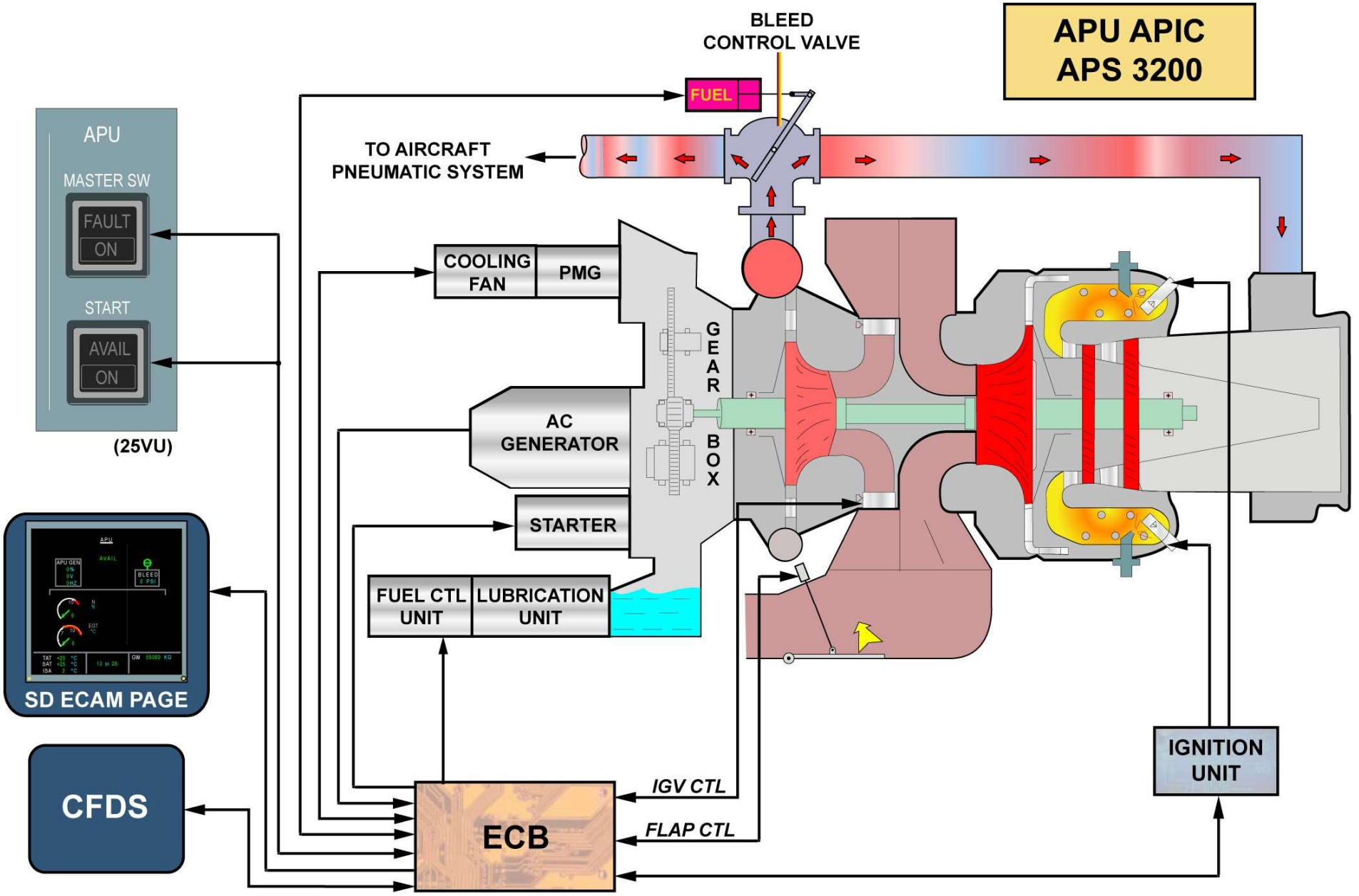
- the starter motor assembly,
- the cooling air fan assembly with the Permanent Magnet Generator (PMG),
- the Fuel Control Unit (FCU),
- the AC generator.

AC GENERATOR

• Transforms the mechanical power into electrical power

•3-phases, 90 KVA, 115 VAC-400Hz

The 3 phases AC generator transforms the mechanical power into electrical power of 90 KVA to supply the electrical A/C system with 115V-400Hz.


APU APIC
APS 3200
BLEED
CONTROL VALVE
FUEL
TO AIRCRAFT
PNEUMATIC SYSTEM
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
(25VU)
COOLING
FAN
PMG
GEAR
BOX
AC
GENERATOR
STARTER
FUEL CTL
UNIT
LUBRICATION
UNIT
SD ECAM PAGE
CFDS
ECB
IGV CTL
FLAP CTL
IGNITION
UNIT

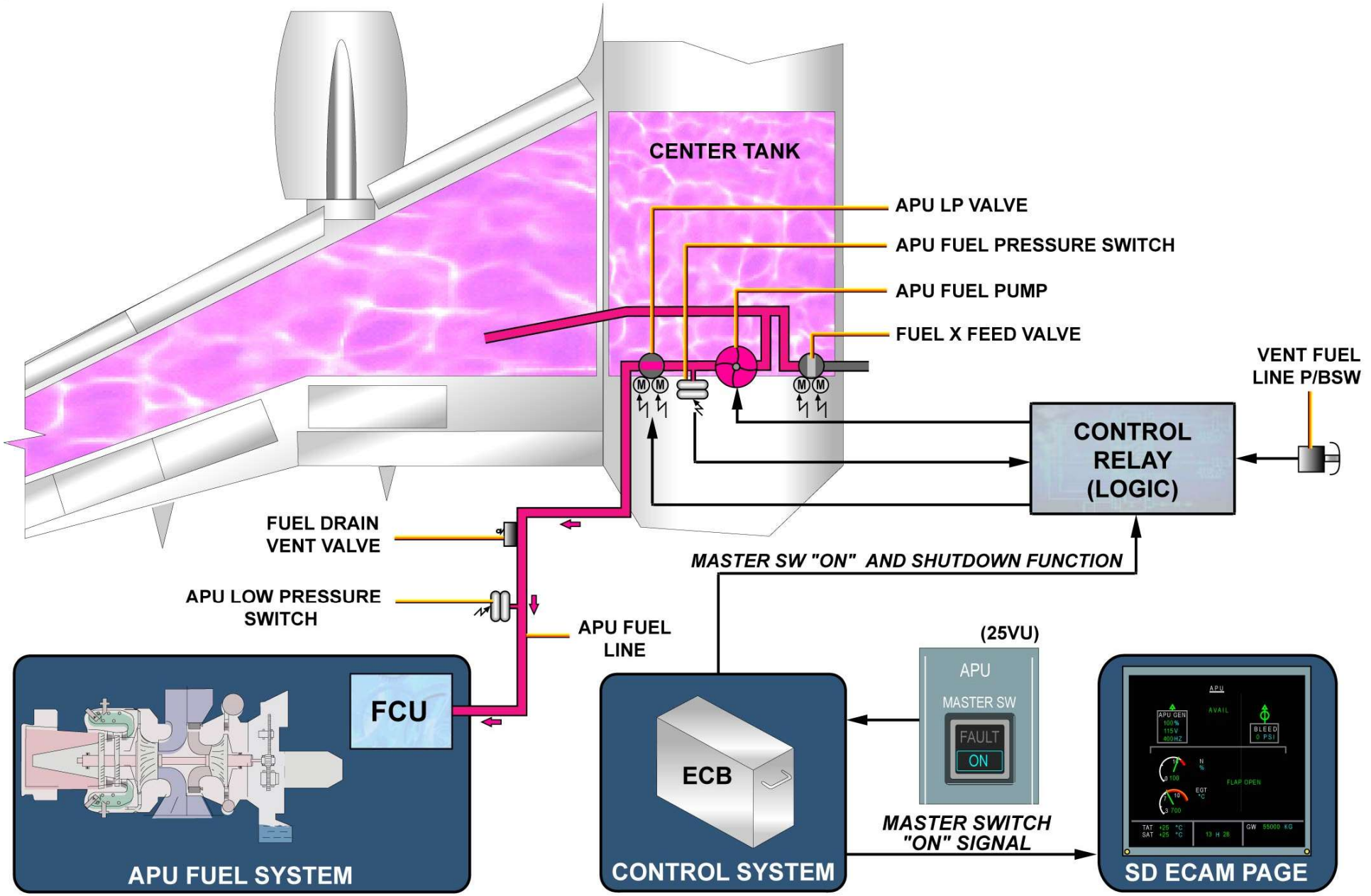
FUEL SYSTEM

• Operates automatically

•Fuel tank pumps, APU fuel pump, APU fuel pressure switch, fuel low pressure valve, fuel LP switch, FCU, fuel line vent and drain valve

The APU is supplied of fuel from either the fuel tank pumps or the APU fuel pump, according to the pressure sensed in the APU fuel feed line upstream of the pump. The APU fuel system operates automatically and includes:

- an APU fuel pump, an APU fuel pressure switch,
- a LP valve,
- a fuel LP switch,
- an FCU for Fuel Flow (FF) scheduling,
- a fuel line vent and drain valve.


CENTER TANK
APU LP VALVE
APU FUEL PRESSURE SWITCH
APU FUEL PUMP
FUEL X FEED VALVE
VENT FUEL LINE P/BSW
CONTROL RELAY (LOGIC)
FUEL DRAIN VENT VALVE
APU LOW PRESSURE SWITCH
APU FUEL LINE
MASTER SW "ON" AND SHUTDOWN FUNCTION
(25VU)
APU
MASTER SW
FAULT
ON
FCU
ECB
MASTER SWITCH "ON" SIGNAL
APU FUEL SYSTEM
CONTROL SYSTEM
SD ECAM PAGE

APU Ignition and Starting Description and Operation

STARTER CONTROL

•Operates APU rotor
•At 55%, ECB stops the starter supply
•ECB timed acceleration loop

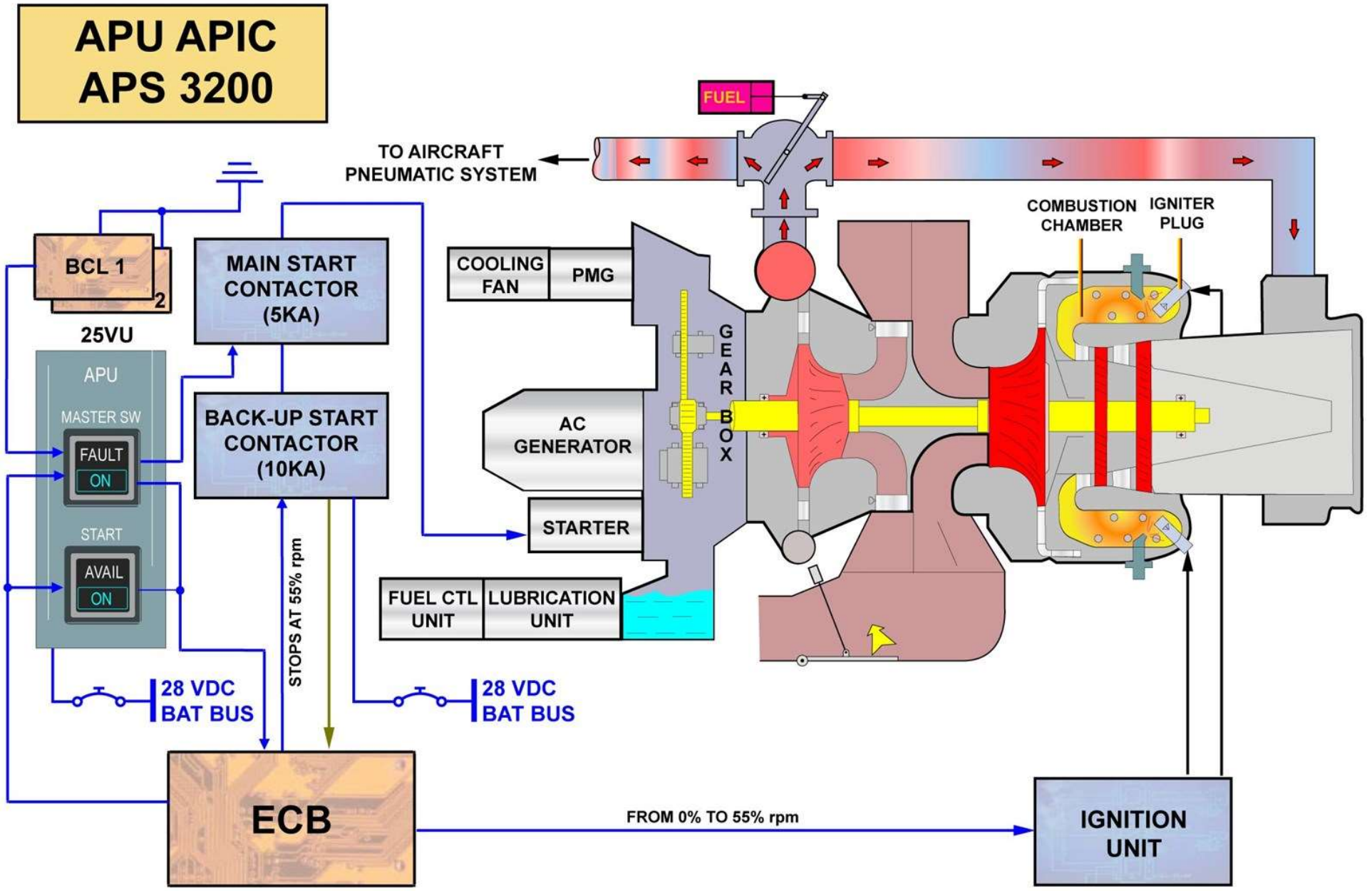
The starting system operates the Auxiliary Power Unit (APU) rotor through a clutch and gearbox. When the APU speed is 55% rpm, the start logic of the Electronic Control Box (ECB) stops the supply to the start contactors, which stops the starter motor. The timed acceleration loop of the ECB causes the APU to increase its speed until it gets to the governed speed.
During Ram Air Turbine (RAT) extension, APU starting is inhibited by the Battery Charge Limiters (BCL 1 and BCL 2). The BCLs remove the ground signal necessary to the operation of the Main Start Contactor from the MASTER SW, and thus prevent operation of the main start contactor 5 KA.

IGNITION CONTROL

•Maintains combustion during the start phase
•Components: ignition unit, leads, and plugs
•Operates from initial crank up to 55% rpm

The ignition system is used to ignite and maintain combustion during the start phase. The ignition system includes:
- an ignition unit,
- two ignition leads,
- two igniter plugs.

The ignition system operates from initial crank up to 55% rpm.


APU APIC
APS 3200
FUEL
TO AIRCRAFT
PNEUMATIC SYSTEM
COMBUSTION
CHAMBER
IGNITER
PLUG
BCL 1
2
25VU
MAIN START
CONTACTOR
(5KA)
COOLING
FAN
PMG
GEAR
BOX
APU
MASTER SW
FAULT
ON
BACK-UP START
CONTACTOR
(10KA)
AC
GENERATOR
START
AVAIL
ON
STARTER
FUEL CTL
UNIT
LUBRICATION
UNIT
STOPS AT 55% rpm
28 VDC
BAT BUS
28 VDC
BAT BUS
ECB
FROM 0% TO 55% rpm
IGNITION
UNIT

APU Fuel System Description and Operation

GENERAL

•Metered fuel to sustain combustion

•Muscle pressure for IGV actuator and bleed control valve actuator

The fuel system provides metered fuel to sustain combustion. Part of the fuel is used as muscle pressure to operate the Inlet Guide Vane (IGV) actuator and the bleed control valve actuator.

FCU

• FCU functions:

- Filtering
- Pressure increase
- Metering
- Shut-off
- Regulation

•FCU components:

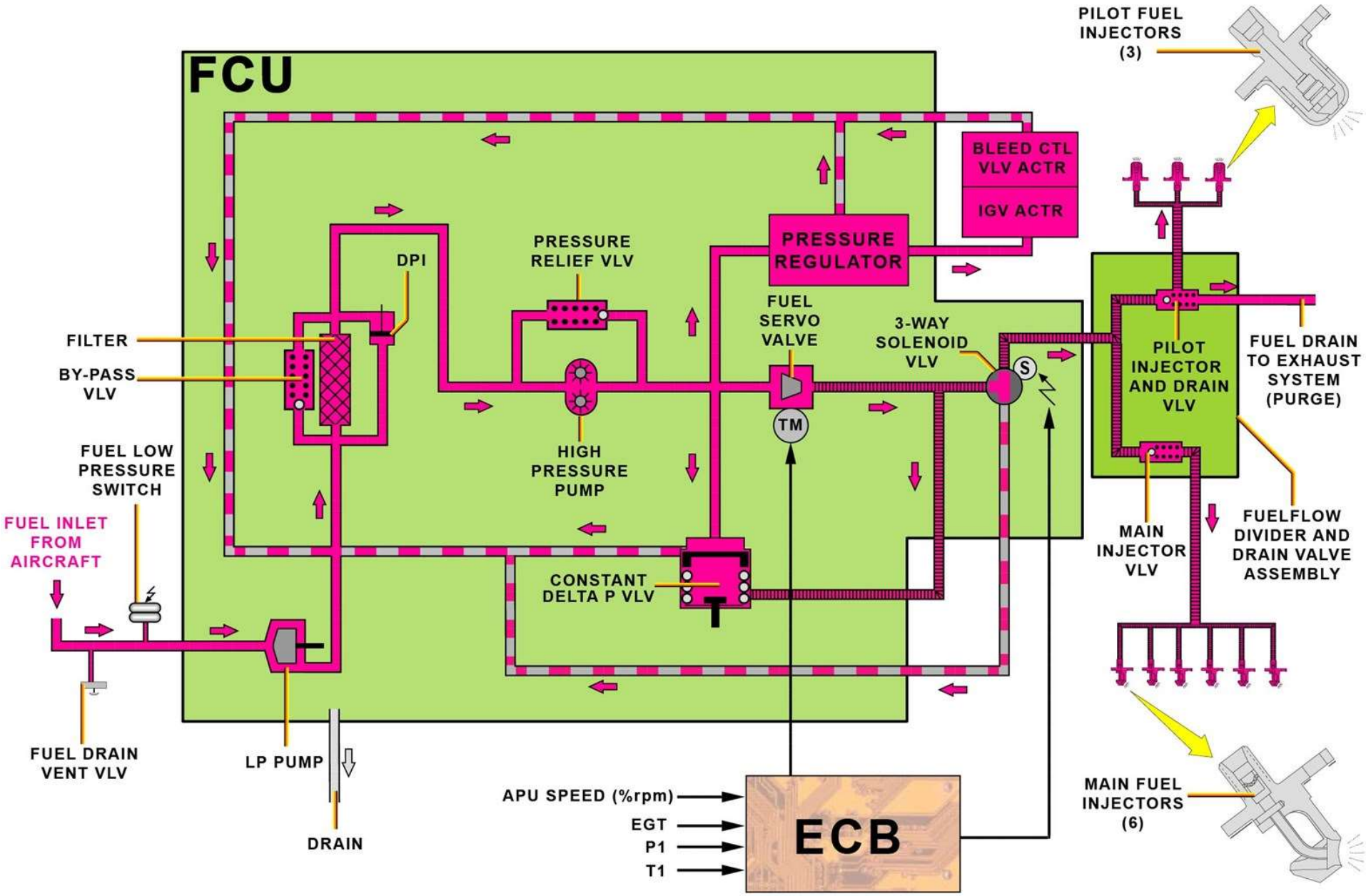
- LP fuel pump
- Filter with Filter by-pass valve and DPI
- HP fuel pump
- Constant ΔP valve
- Pressure regulator for IGV and bleed control valve actuators
- Fuel servovalve
- 3-way solenoid valve

•FCU drain to purge pump shaft seal

The Fuel Control Unit (FCU) has five functions:

- fuel filtering,
- pressure increase,
- fuel metering,
- positive fuel shut-off,
- fuel muscle pressure regulation.

The FCU is composed of a Low Pressure (LP) fuel pump, a filter with a filter by-pass valve and a Differential Pressure Indicator (DPI), a High Pressure (HP) fuel pump with a pressure relief valve, a constant Differential Pressure (DELTA P) valve, a pressure regulator for the bleed control valve and the IGV actuators, a fuel servovalve, and the 3-way solenoid valve. A FCU drain line purges the pump shaft seal.


FCU
PILOT FUEL INJECTORS (3)
BLEED CTL VLV ACTR
IGV ACTR
PRESSURE REGULATOR
PRESSURE RELIEF VLV
DPI
FUEL SERVO VALVE
3-WAY SOLENOID VLV
S
TM
FILTER
BY-PASS VLV
HIGH PRESSURE PUMP
PILOT INJECTOR AND DRAIN VLV
FUEL DRAIN TO EXHAUST SYSTEM (PURGE)
FUEL LOW PRESSURE SWITCH
FUEL INLET FROM AIRCRAFT
CONSTANT DELTA P VLV
MAIN INJECTOR VLV
FUELFLOW DIVIDER AND DRAIN VALVE ASSEMBLY
FUEL DRAIN VENT VLV
LP PUMP
DRAIN
APU SPEED (%rpm)
EGT
P1
T1
ECB
MAIN FUEL INJECTORS (6)

APU START
FUEL PRESSURE

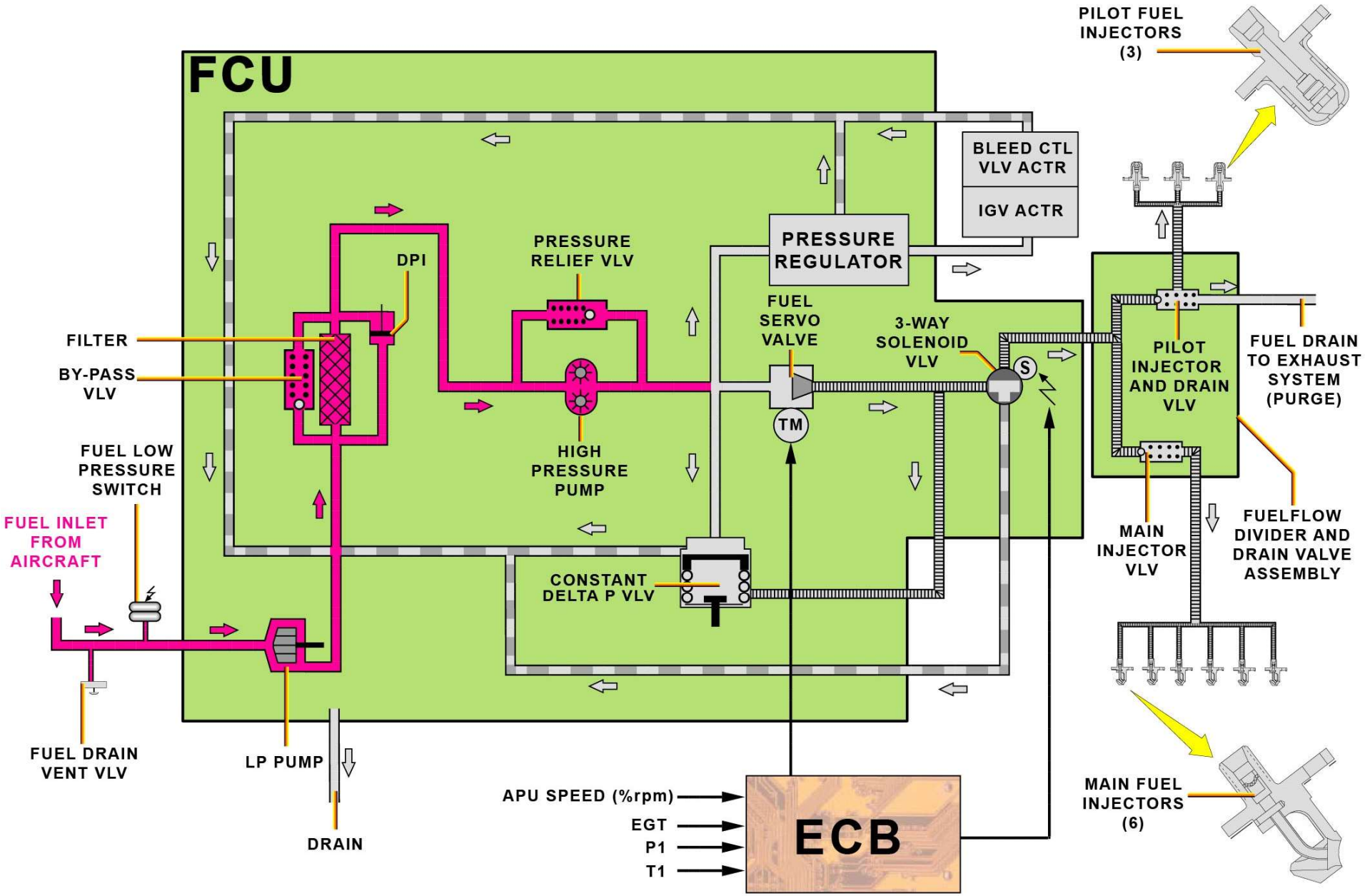
• APU start
    - Fuel comes from A/C system
    - LP pump
    - Filter
    - HP pump

•Filter becomes contamined
    - DPI indicates

•Filter blocked
    - By-pass open

•Pressure relief valve of HP pump
    - To cut off excessive peaks

As the Auxiliary Power Unit (APU) is started the fuel coming from the aircraft fuel system flows through the Low Pressure (LP) pump, through a filter to the High Pressure (HP) pump.
If the filter becomes contaminated, the impending filter bypass will be indicated by the Differential Pressure Indicator (DPI).
When the filter is blocked the by-pass valve will open. The HP pump has a pressure relief valve to cut off excessive pressure peaks.


FCU
PILOT FUEL INJECTORS (3)
BLEED CTL VLV ACTR
IGV ACTR
PRESSURE REGULATOR
DPI
PRESSURE RELIEF VLV
FUEL SERVO VALVE
3-WAY SOLENOID VLV
S
TM
FILTER
BY-PASS VLV
FUEL LOW PRESSURE SWITCH
HIGH PRESSURE PUMP
PILOT INJECTOR AND DRAIN VLV
FUEL DRAIN TO EXHAUST SYSTEM (PURGE)
FUEL INLET FROM AIRCRAFT
CONSTANT DELTA P VLV
MAIN INJECTOR VLV
FUELFLOW DIVIDER AND DRAIN VALVE ASSEMBLY
FUEL DRAIN VENT VLV
LP PUMP
DRAIN
APU SPEED (%rpm)
EGT
P1
T1
ECB
MAIN FUEL INJECTORS (6)

ECB FUNCTIONS

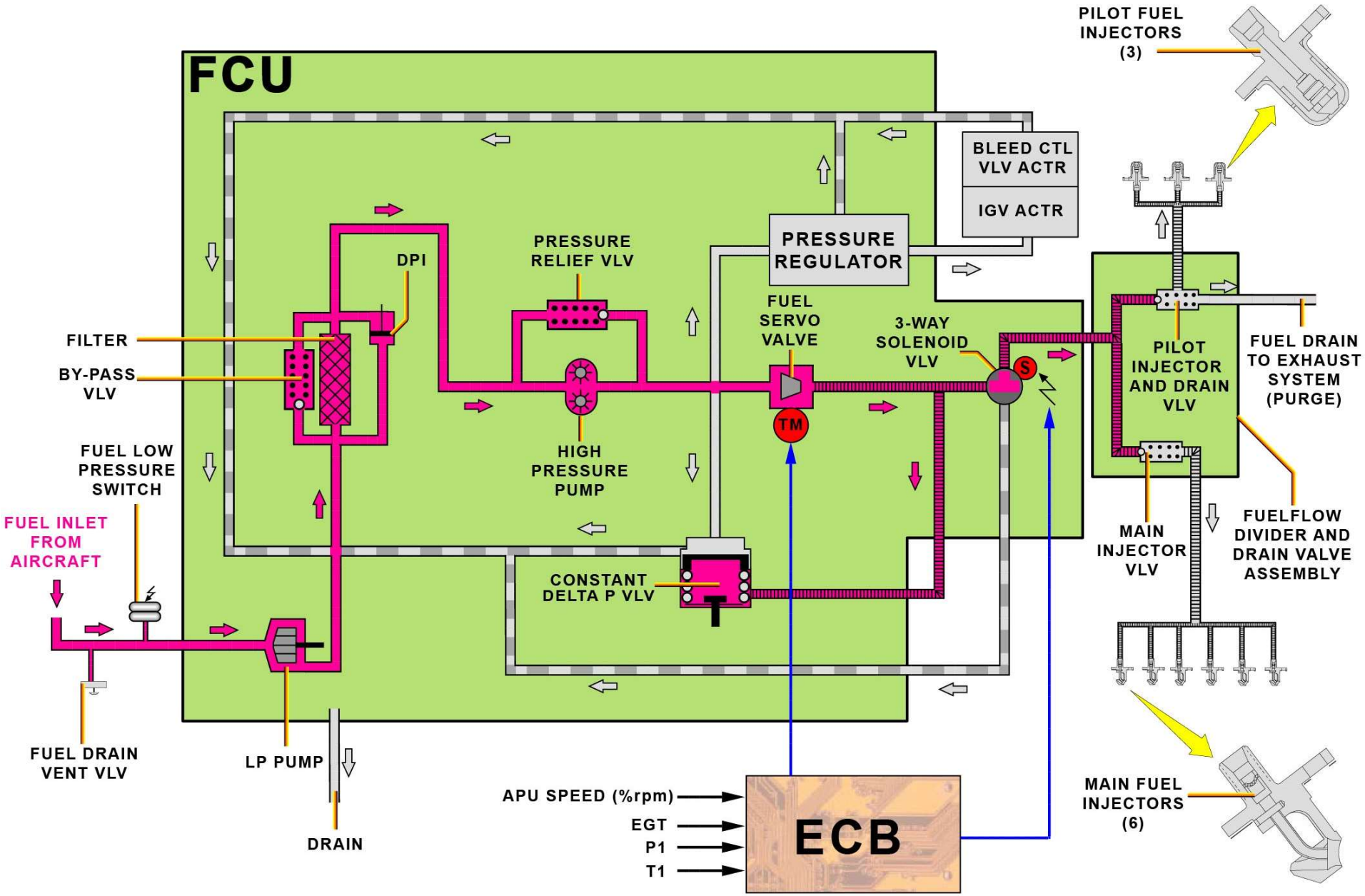
• ECB functions:

- To control fuel servovalve
- To schedule fuel flow during start
- To modulate the on-speed fuel schedule following A/C bleed demand and electrical load

•HP pump: excessive pressure peaks

- Pressure relief valve open

During the APU start, the Electronic Control Box (ECB) energizes the 3-way solenoid valve and the Torque Motor (TM) of the fuel servo valve. The fuel, pressurized by the HP pump, then flows through the servo valve and through the 3-way solenoid valve to the flow divider. The ECB schedules fuel flow for start sequence, on speed operation and shutdown sequence. The ECB modulates the on-speed fuel schedule to match the A/C demand for bleed air and electrical load.

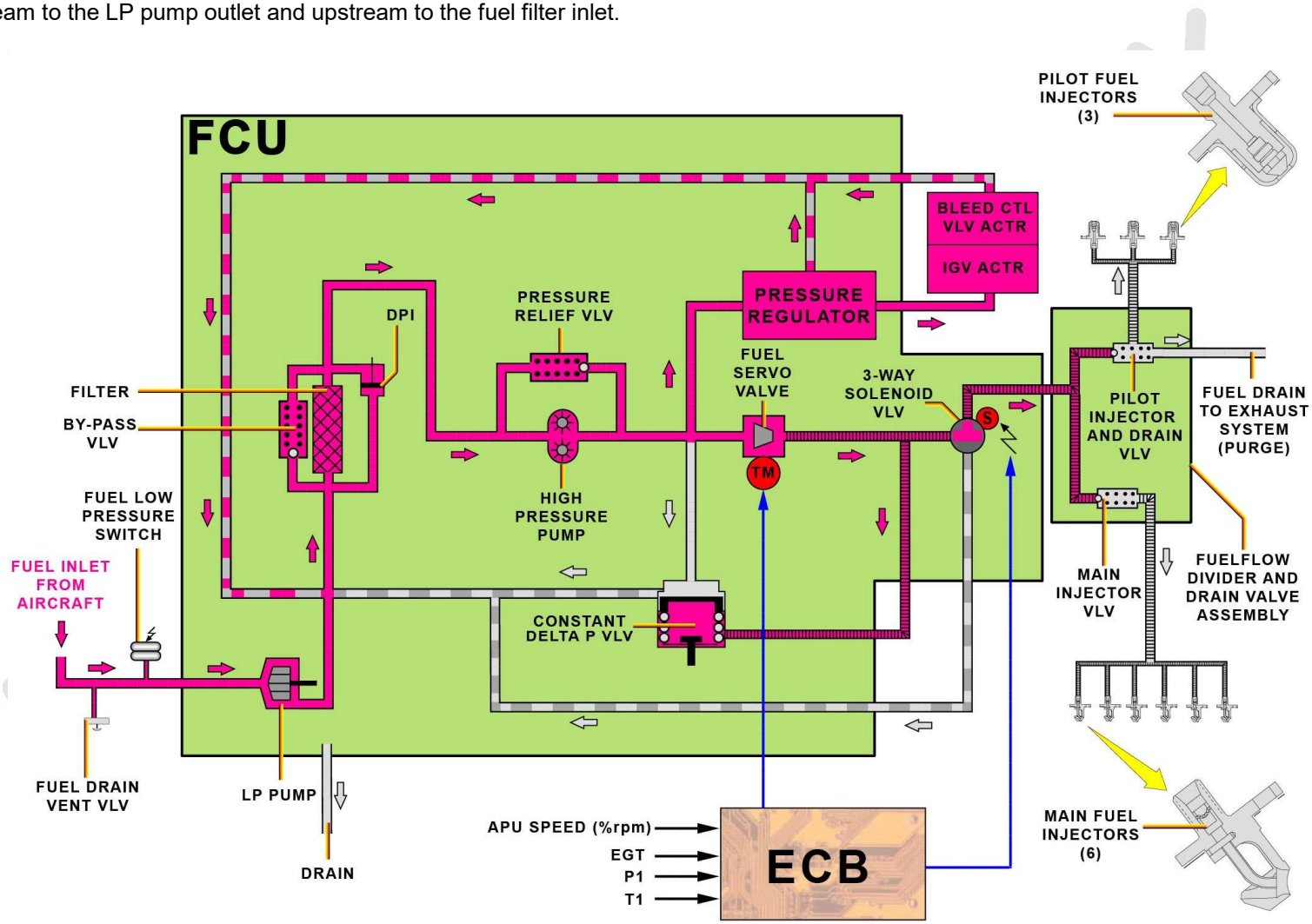

FCU
PILOT FUEL INJECTORS (3)
BLEED CTL VLV ACTR
IGV ACTR
PRESSURE REGULATOR
DPI
PRESSURE RELIEF VLV
FUEL SERVO VALVE
3-WAY SOLENOID VLV
FILTER
BY-PASS VLV
TM
S
PILOT INJECTOR AND DRAIN VLV
FUEL DRAIN TO EXHAUST SYSTEM (PURGE)
FUEL LOW PRESSURE SWITCH
HIGH PRESSURE PUMP
FUEL INLET FROM AIRCRAFT
CONSTANT DELTA P VLV
MAIN INJECTOR VLV
FUELFLOW DIVIDER AND DRAIN VALVE ASSEMBLY
FUEL DRAIN VENT VLV
LP PUMP
DRAIN
APU SPEED (%rpm)
EGT
P1
T1
ECB
MAIN FUEL INJECTORS (6)

FUEL SCHEDULE

• To operate the bleed control valve actuator and IGV actuator

•Servo fuel returns between outlet of LP fuel pump and fuel filter inlet

From the HP pump, the fuel also flows to the pressure regulator. The fuel muscle pressure is used to operate the bleed control valve actuator, for the air delivery to the A/C and the air discharge to the exhaust, and for the load compressor IGV actuator. Servo fuel is returned downstream to the LP pump outlet and upstream to the fuel filter inlet.

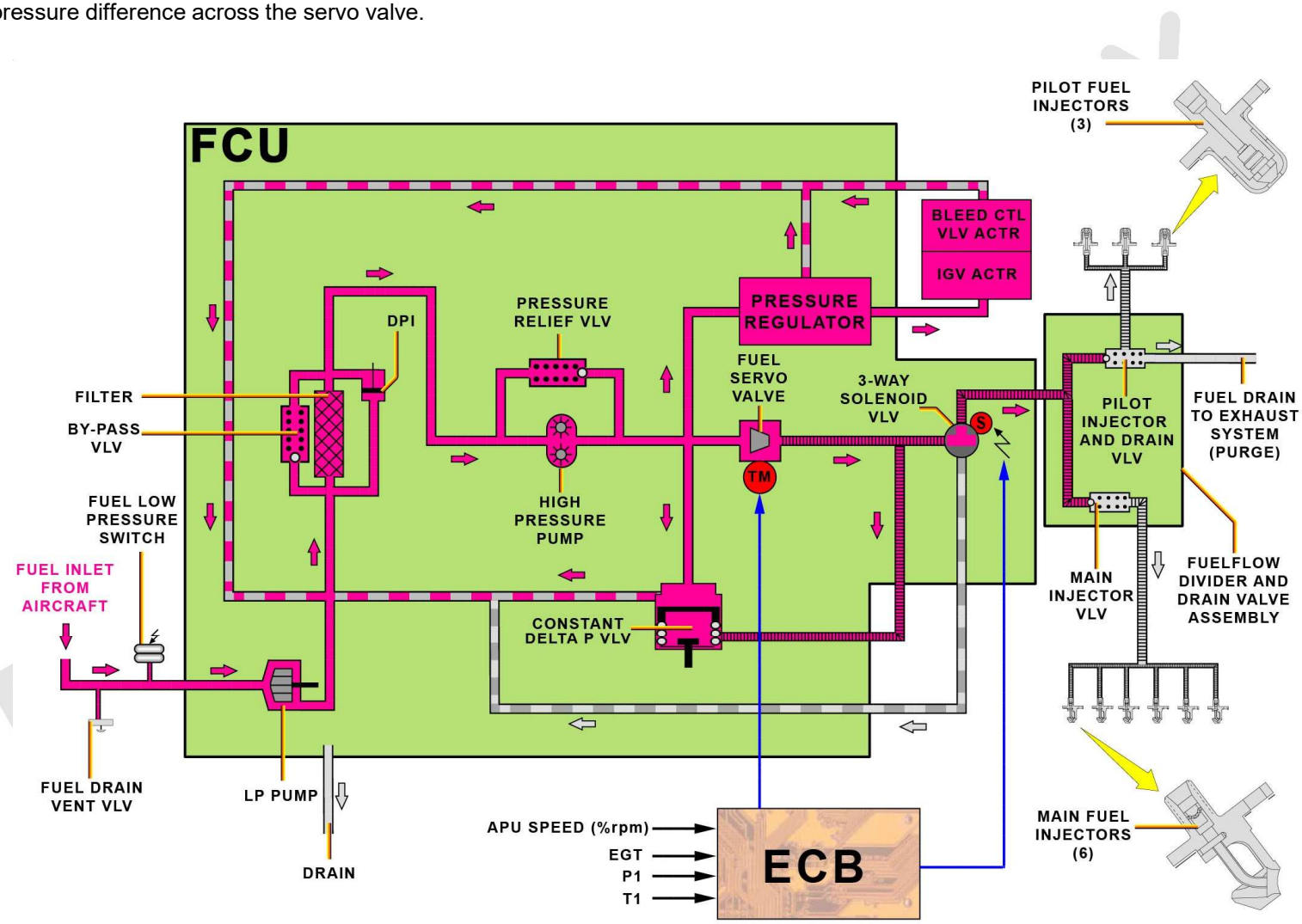


DELTA PRESSURE VALVE

• DELTA P valve

- Excessive fuel from HP pump flow back to the filter inlet
- Maintains a constant pressure difference across servo valve

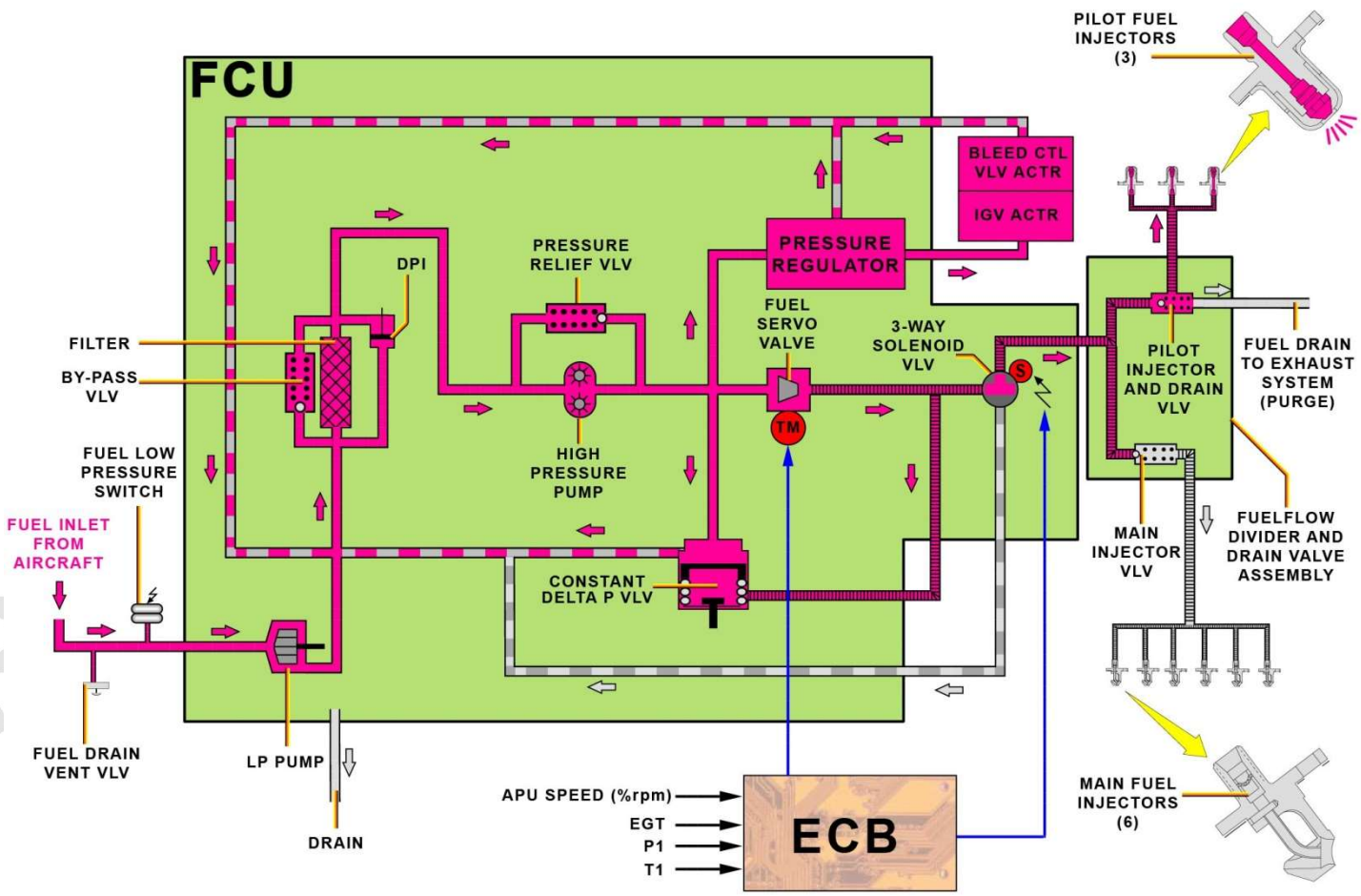
The constant Differential Pressure (DELTA P) valve lets excessive fuel from the HP pump flow back to the filter inlet and maintains a constant pressure difference across the servo valve.



FLOW DIVIDER

• Flow divider & drain valve
  • Divides fuel between pilot and main injectors
•During start sequence:
  • Pilot injector valve opens when fuel pressure =20psi
  • Supply the 3 pilot fuel injectors

The flow divider and drain valve assembly divides the fuel between the pilot and main injectors. During the start sequence, the pilot injector valve opens when the fuel pressure reaches 20 psi to initially supply the 3 pilot fuel injectors.



•Fuel pressure increases
- Main injector valve opens
- Fuel supplied to the 6 main fuel injectors

•APU running: two valves in open position an all injectors supplied

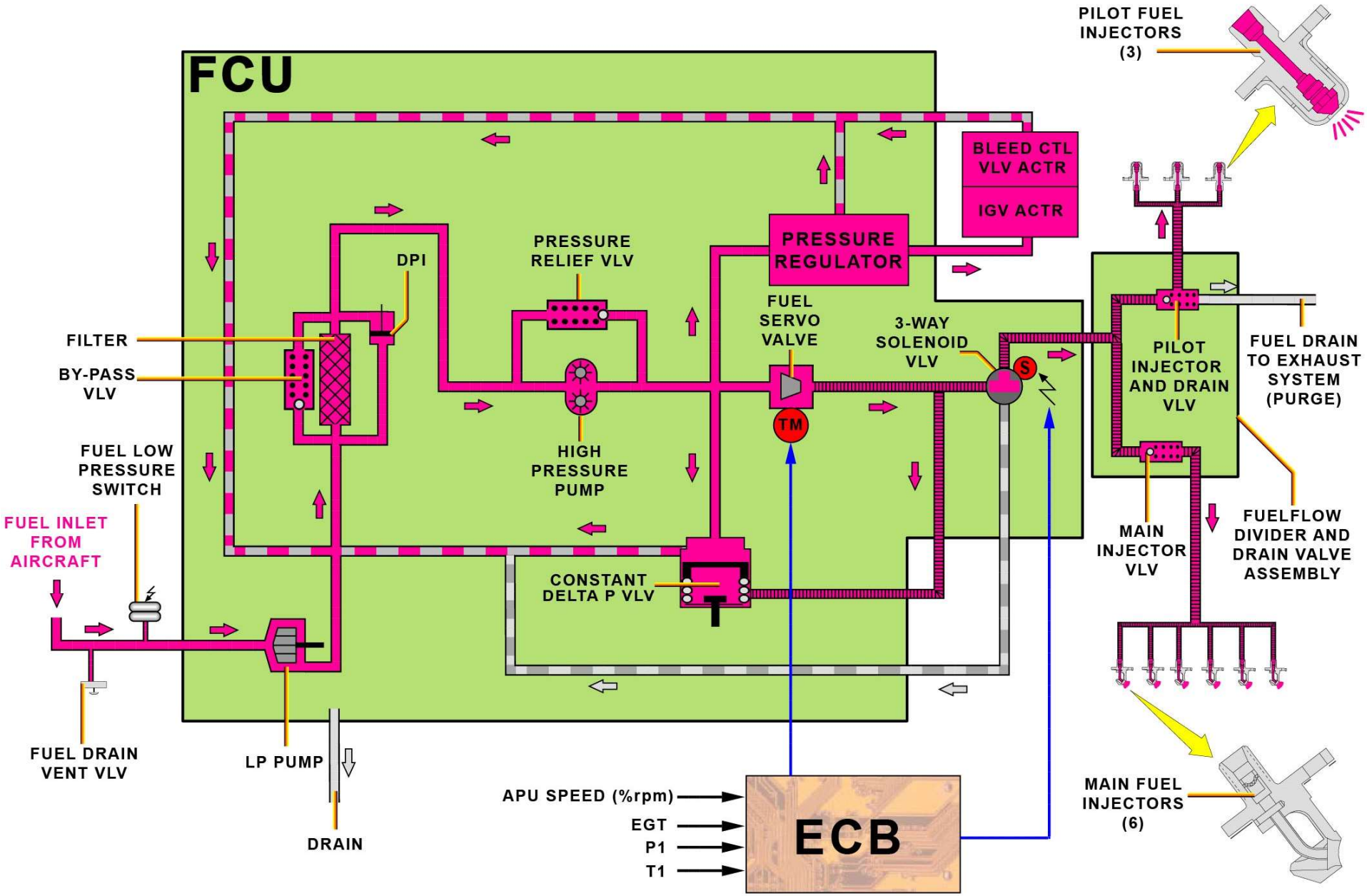
As the fuel pressure increases, the main injector valve opens and fuel is supplied to the 6 main fuel injectors. When the APU is running, the two valves are in the open position to supply all injectors.

•10 ECB controls fuel system using several parameters

•During start sequence: APU speed, EGT, air inlet pressure and temperature

•During steady-state operation: speed only

The ECB controls the fuel system using several parameters. During the start sequence, it uses APU speed, Exhaust Gas Temperature (EGT), air inlet pressure and temperature. During steady-state operation the ECB uses the speed only.


FCU
PILOT FUEL INJECTORS (3)
BLEED CTL VLV ACTR
IGV ACTR
PRESSURE REGULATOR
DPI
PRESSURE RELIEF VLV
FUEL SERVO VALVE
3-WAY SOLENOID VLV
FILTER
BY-PASS VLV
TM
S
PILOT INJECTOR AND DRAIN VLV
FUEL DRAIN TO EXHAUST SYSTEM (PURGE)
FUEL LOW PRESSURE SWITCH
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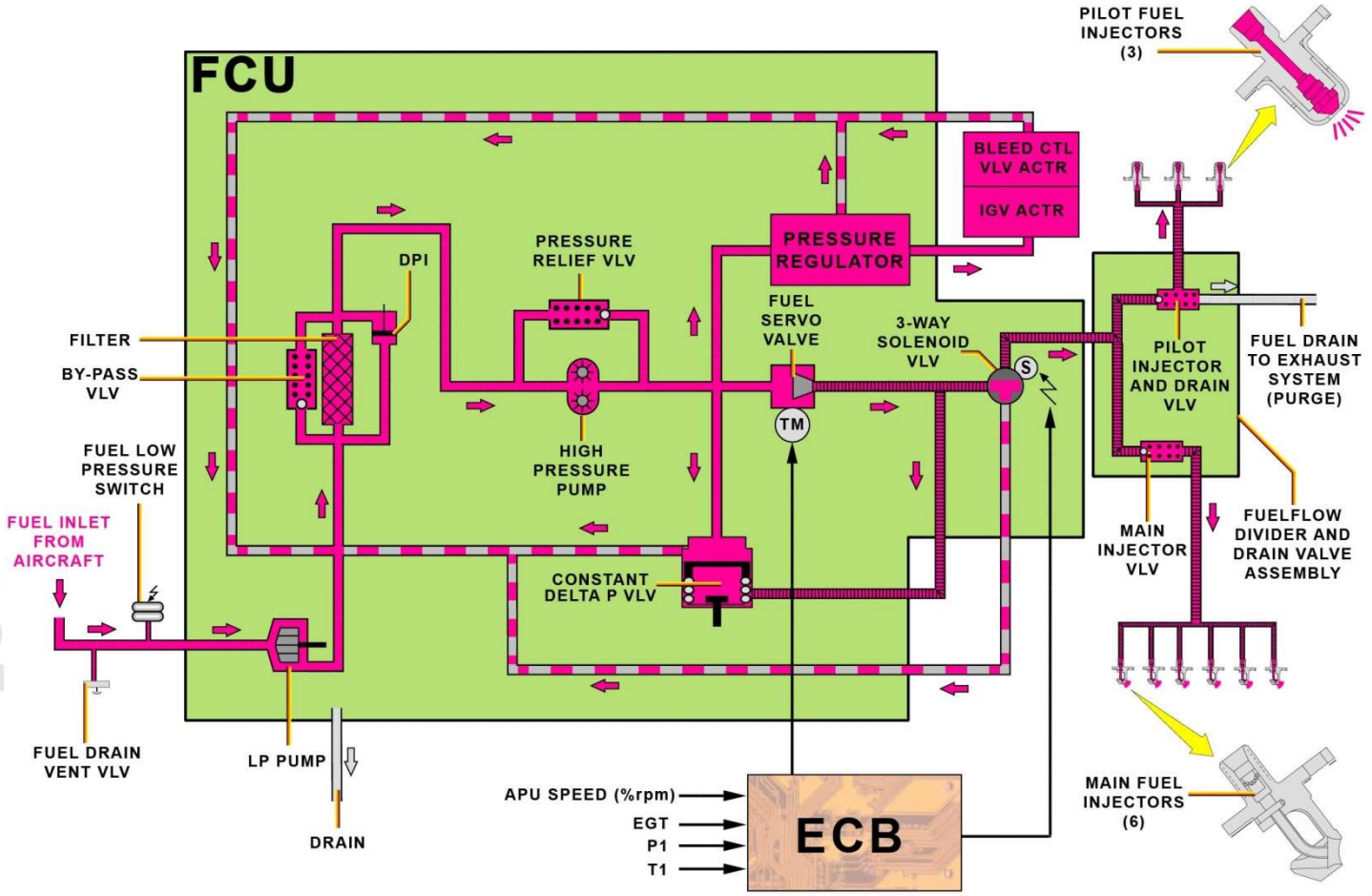
CONSTANT DELTA P VLV
MAIN INJECTOR VLV
FUELFLOW DIVIDER AND DRAIN VALVE ASSEMBLY
FUEL DRAIN VENT VLV
LP PUMP
DRAIN
APU SPEED (%rpm)
EGT
P1
T1
ECB
MAIN FUEL INJECTORS (6)

APU SHUTDOWN
FUEL INJECTORS CUT OFF

• APU shutdown:
  - ECB de-energizes 3-way solenoid valve
  - Fuel returned to the fuel filter inlet
  - Fuel supply to the fuel injectors is cut off

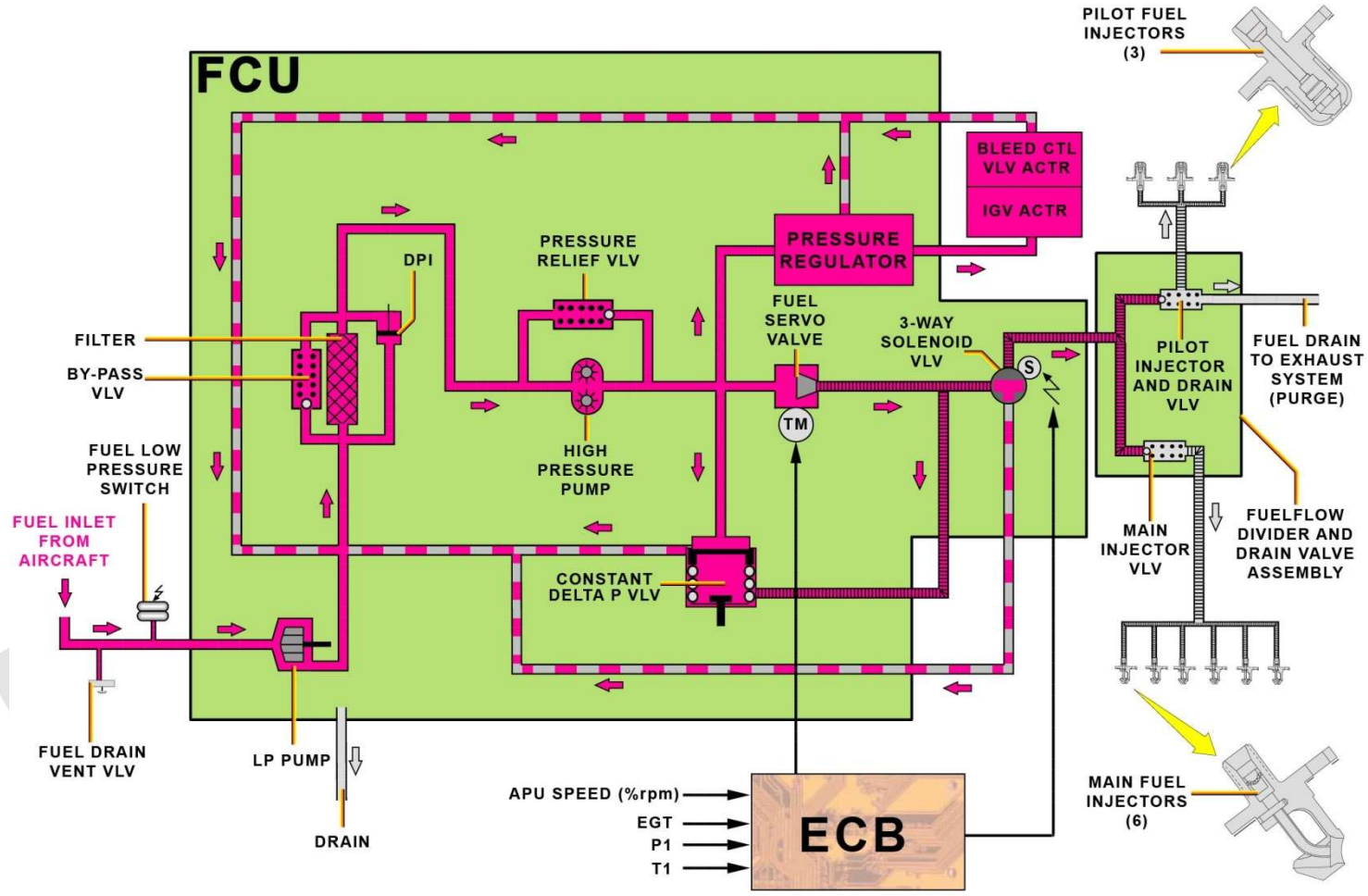
When the APU shutdown is initiated, the ECB de-energizes the 3-way solenoid valve for positive fuel shut-off. Fuel is returned to the fuel filter inlet. The fuel supply to the fuel injectors is cut off.



FUEL DRAIN AND VENT VALVE

• Fuel pressure decreases in flow divider
    • 2 injectors valves close
•Fuel remaining in pilot injectors purged to APU exhaust

As the fuel pressure decreases in the flow divider and drain valve assembly, the two injector valves close. The fuel remaining in the pilot injectors is purged to the APU exhaust by combustion chamber pressure.



APU Oil System Description and Operation

GENERAL

STORAGE

• Sump is oil reservoir with 5.2 l (1.4 US gal)
•Gravity fill port on the left side of the gearbox with scupper
•Gearbox with pressure fill port, overflow port, sight glass

The sump of the Auxiliary Power Unit (APU) accessory gearbox is the oil reservoir. The accessory gearbox sump contains 5.2 l (1.4 US gal) of oil. On the left hand side of the gearbox, a gravity fill port is installed with a scupper to drain spilled oil. The gearbox has:

- a pressure fill port,
- an overflow port,
- a sight glass.

PROTECTION

• Protected by ECB in case of oil malfunction
•Monitoring of the oil pressure and temperature
•ECB automatic shutdown when:

- Gearbox High oil temperature (HOT) threshold is 135 º C (275 F)
- AC generator HOT threshold is 180 º C (356 F)
- Oil low pressure threshold is 30 psi

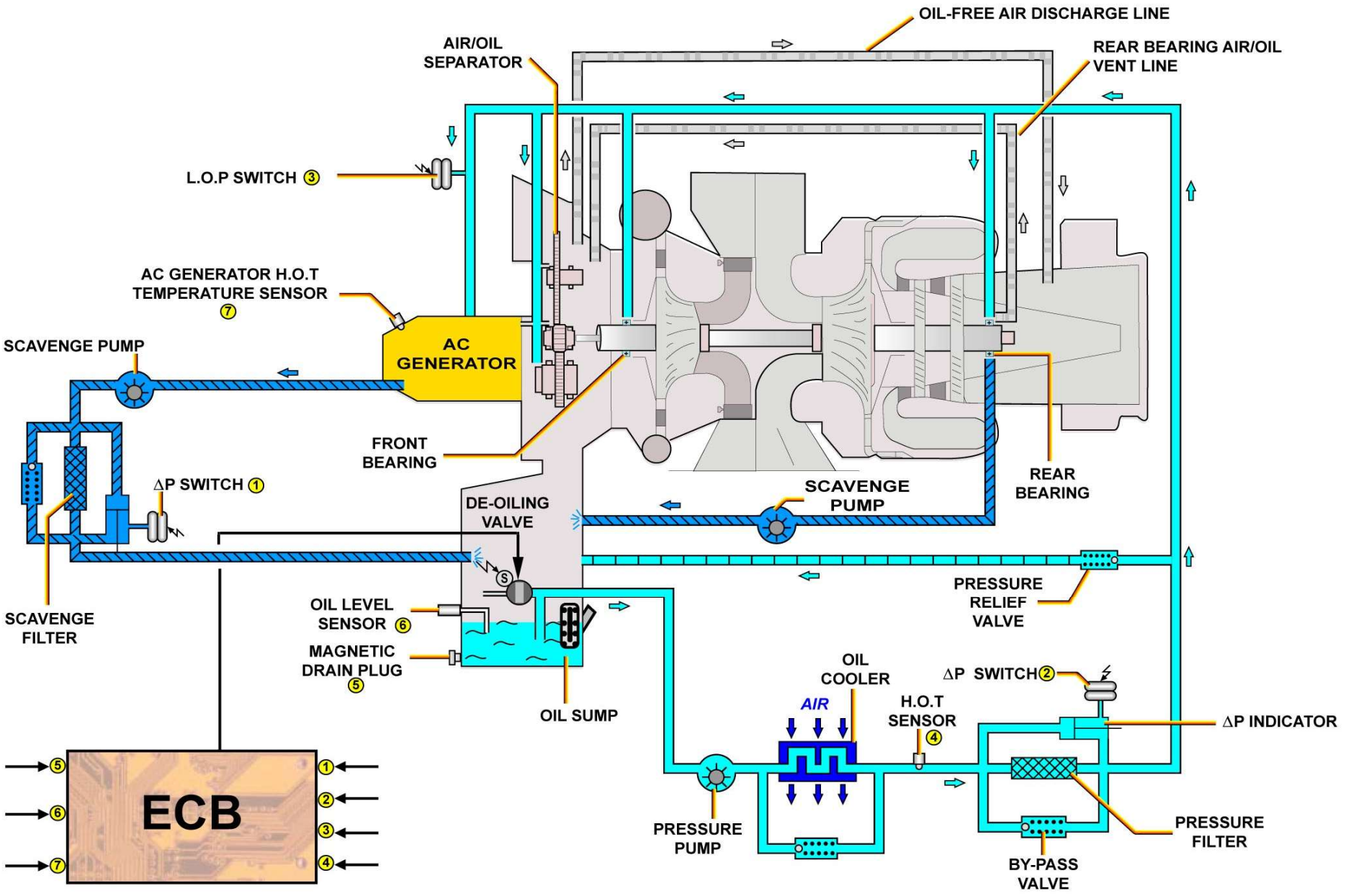
The ECB protects the APU in case of oil system malfunction. The ECB monitors oil pressure and oil temperature. If one of the oil parameters is out of range, the ECB initiates an automatic APU shutdown without time delay.

- gearbox High Oil Temperature (HOT) threshold: 135 º C (275 F),
- AC generator high oil temp: 180 º C (356 F),
- Low Oil Pressure (LOP): 35 psi.

MONITORING

• Monitoring to increase APU life
•Lube and scavenge filter with visual clogging indicators
•Oil sump has a low level sensor
•With oil low level, the APU is able to run at least 60 hours
•Magnetic drain plug makes the oil drainage and chip detection

The oil system is monitored to increase the APU life. Lube and scavenge filters have visual clogging indicators. The oil sump has a low level sensor to show maintenance information in the cockpit. When the level is at the "ADD" mark 4l (1 US gal) the APU is able to continue running for at least 60 hours. A magnetic drain plug, immersed in the APU oil, is used for the oil drainage from the sump and attracts ferrous metal particles. Two Differential Pressure (DELTA P) switches, one for the scavenge filter and a second one for the pressure filter are use for the ECB in case of clogging situation and an APU auto shutdown is triggered.


OIL-FREE AIR DISCHARGE LINE
AIR/OIL SEPARATOR
REAR BEARING AIR/OIL VENT LINE
L.O.P SWITCH ③
AC GENERATOR H.O.T TEMPERATURE SENSOR ⑦
AC GENERATOR
SCAVENGE PUMP
FRONT BEARING
REAR BEARING
ΔP SWITCH ①
DE-OILING VALVE
SCAVENGE PUMP
PRESSURE RELIEF VALVE
SCAVENGE FILTER
OIL LEVEL SENSOR ⑥
MAGNETIC DRAIN PLUG ⑤
OIL SUMP
OIL COOLER
AIR
ΔP SWITCH ②
H.O.T SENSOR ④
ΔP INDICATOR
ECB
PRESSURE PUMP
PRESSURE FILTER
BY-PASS VALVE

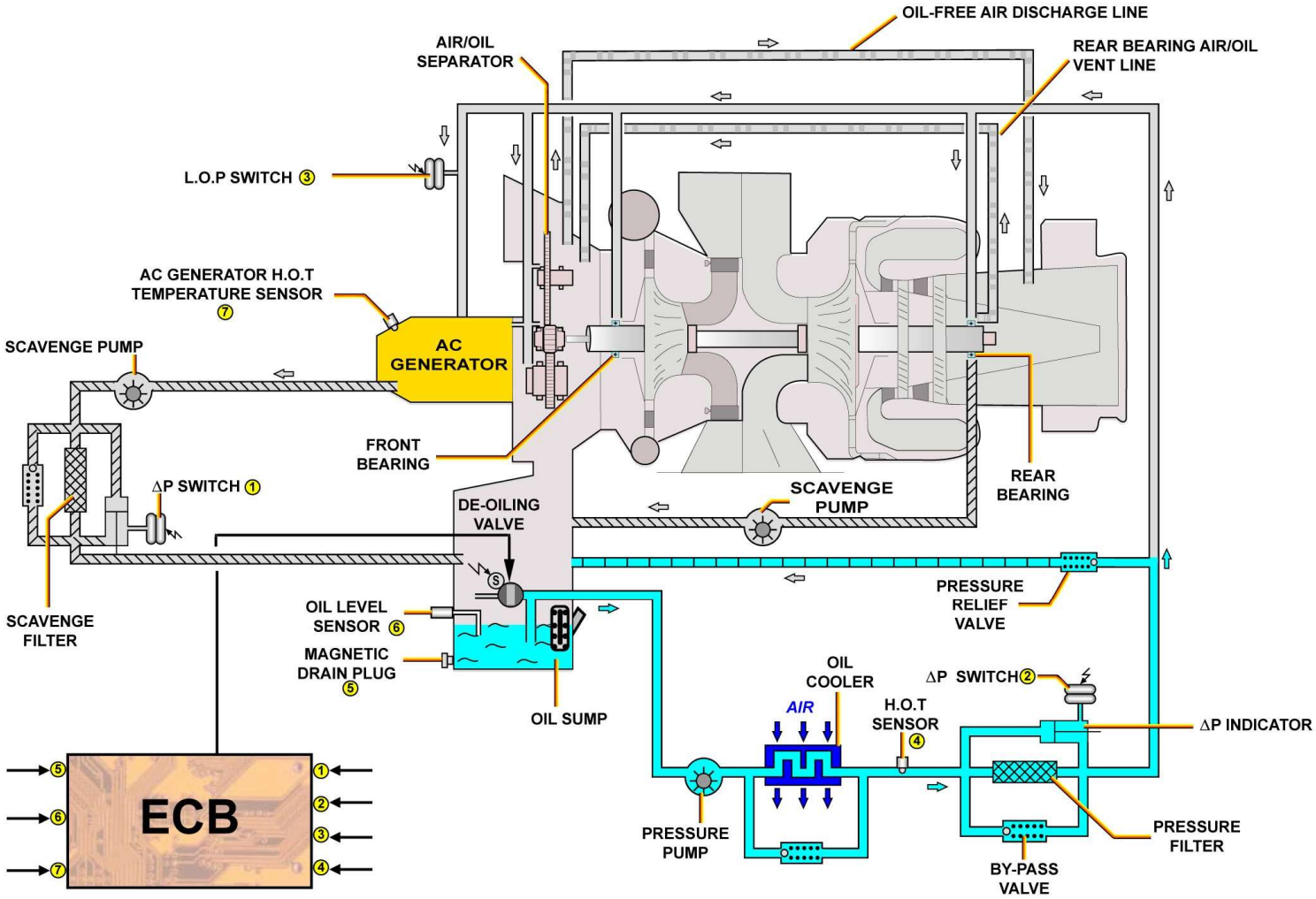
SUPPLY

• Oil pressurized from vane-type pressure pump

•Pressurized oil through cooler and filter

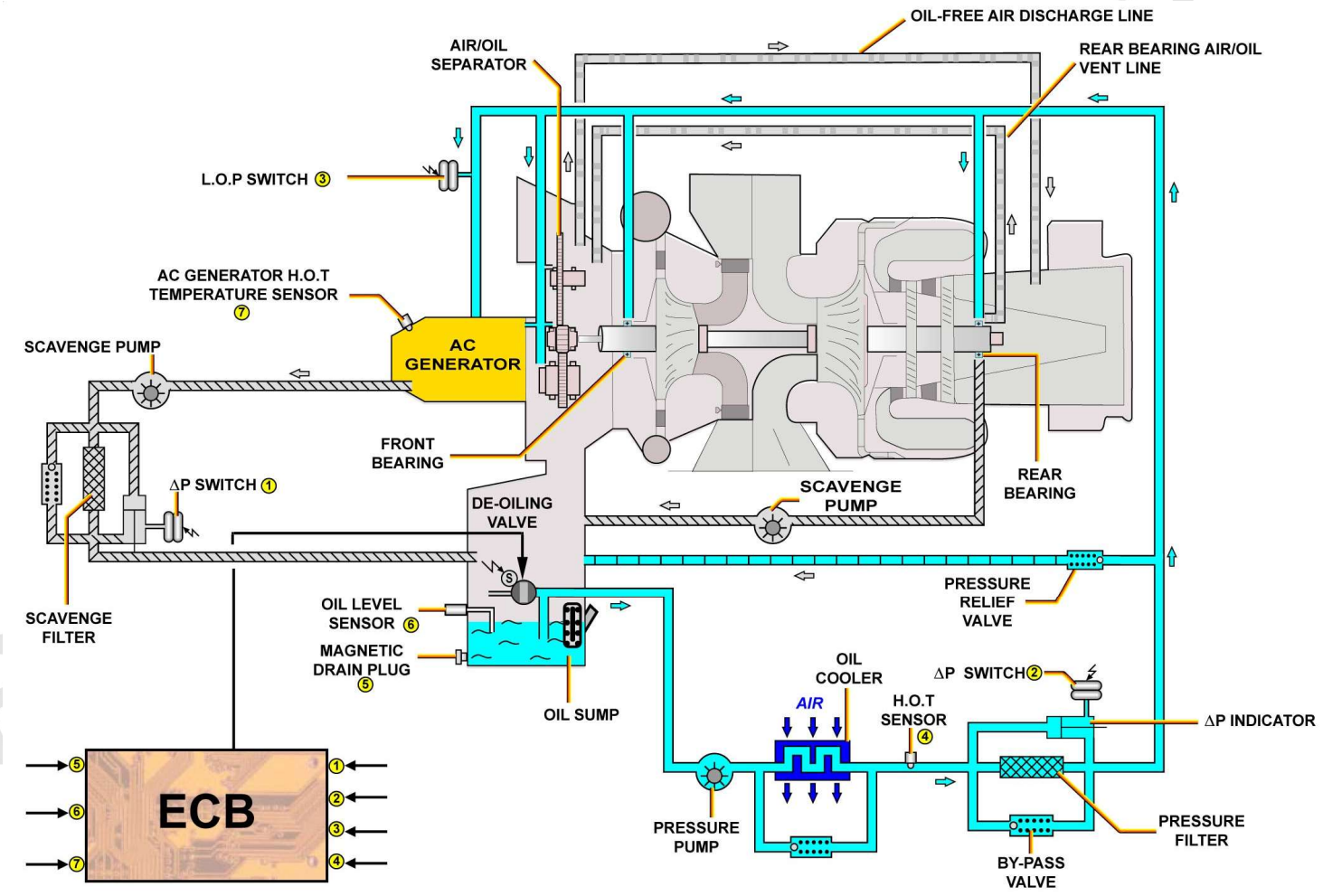
•In case of pump overpressure, a pressure relief valve opens and releases oil back to pump inlet

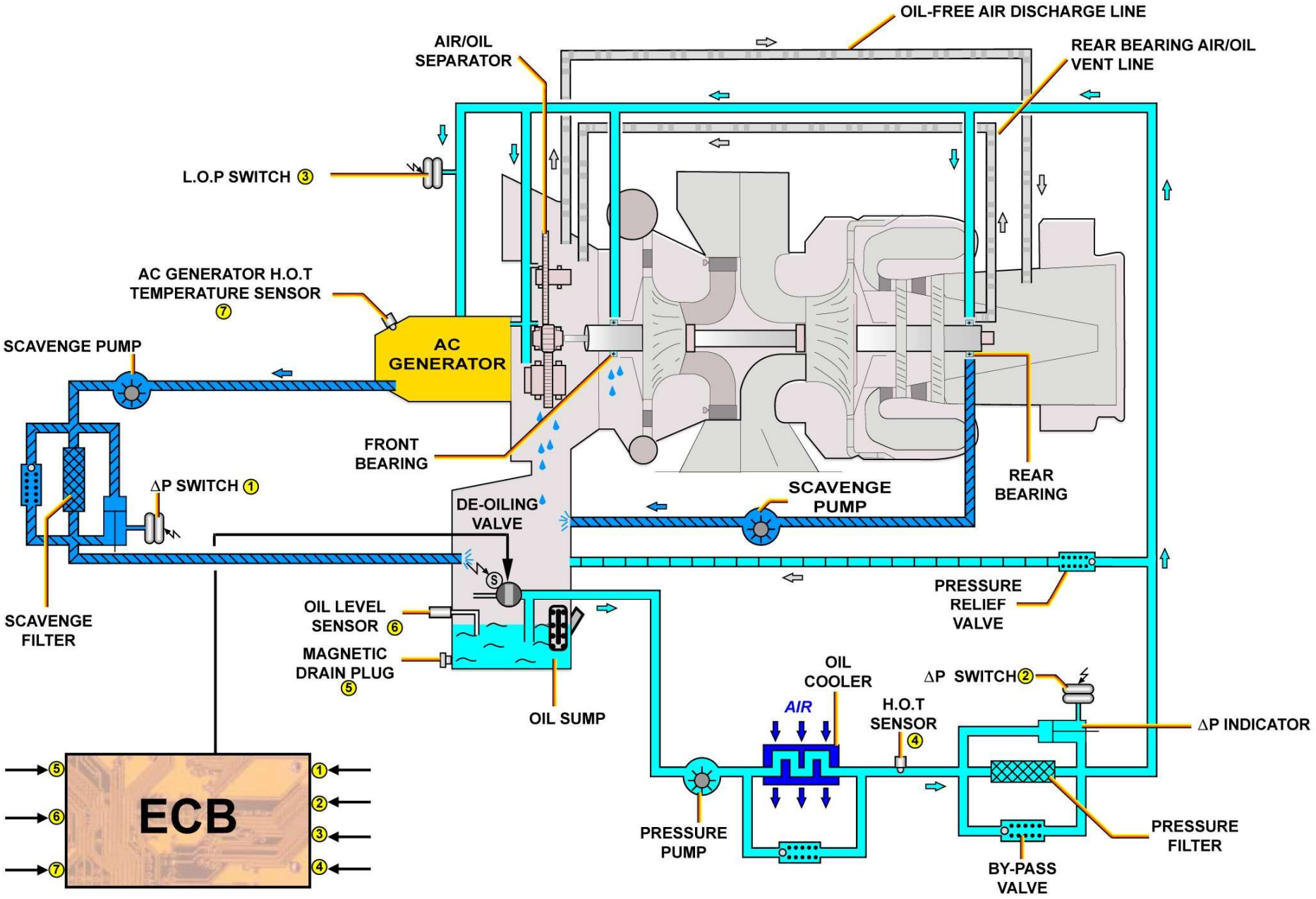
The oil is drawn from the sump and pressurized by a vane-type pressure pump. The pressurized oil goes through a cooler and a disposable filter. If the pump pressure is too high, a pressure relief valve opens and releases oil back to the pump inlet.



•Oil directed to the gears and bearings of accessory gearbox, the load compressor front bearing, the power section rear bearing and electrical generator

The oil is then directed to the gears and bearings of the accessory gearbox, the load compressor front bearing, the power section rear bearing and the electrical generator.




OIL-FREE AIR DISCHARGE LINE
AIR/OIL SEPARATOR
REAR BEARING AIR/OIL VENT LINE
L.O.P SWITCH ③
AC GENERATOR H.O.T TEMPERATURE SENSOR ⑦
AC GENERATOR
SCAVENGE PUMP
FRONT BEARING
REAR BEARING
ΔP SWITCH ①
DE-OILING VALVE
SCAVENGE PUMP
PRESSURE RELIEF VALVE
SCAVENGE FILTER
OIL LEVEL SENSOR ⑥
MAGNETIC DRAIN PLUG ⑤
OIL SUMP
OIL COOLER
AIR
ΔP SWITCH ②
H.O.T SENSOR ④
ΔP INDICATOR
ECB
PRESSURE PUMP
PRESSURE FILTER
BY-PASS VALVE

SCAVENGE

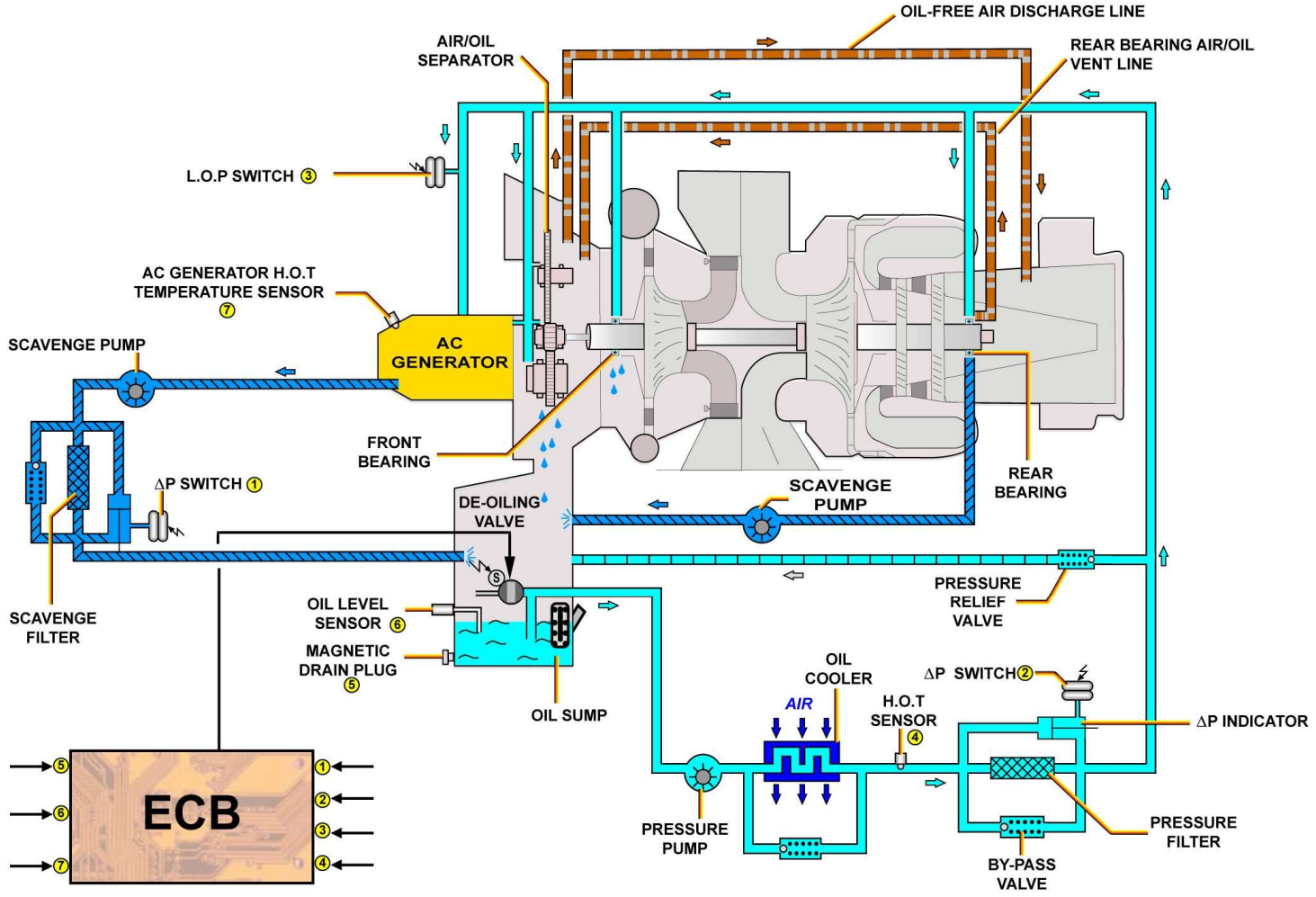
• Oil scavenged to the sump
•One scavenge pump and a scavenge filter for AC generator
•One scavenge pump for rear bearing
•Oil from gearbox pinions and front bearing scavenged by gravity

Oil from the electrical generator and the APU rear bearing is returned to the sump by two scavenge pumps. The oil from the AC generator returns to the sump through a vane-type scavenge pump and a filter. The oil from the APU rear bearing returns to the sump through a scavenge pump. Oil from the gearbox pinions and the APU front bearing is scavenged by gravity.

VENTING

•Air oil mist from rear bearing returns to gearbox housing
•Air/oil separator
•Oil-free air discharged in the exhaust

The air oil mist from the rear bearing is returned to the gearbox housing through an external pipe. An air/oil separator removes the oil particles from the gearbox air. This oil-free air is discharged in the APU exhaust.



DE-OILING SOLENOID FUNCTION

• ECB controls the de-oiling solenoid valve

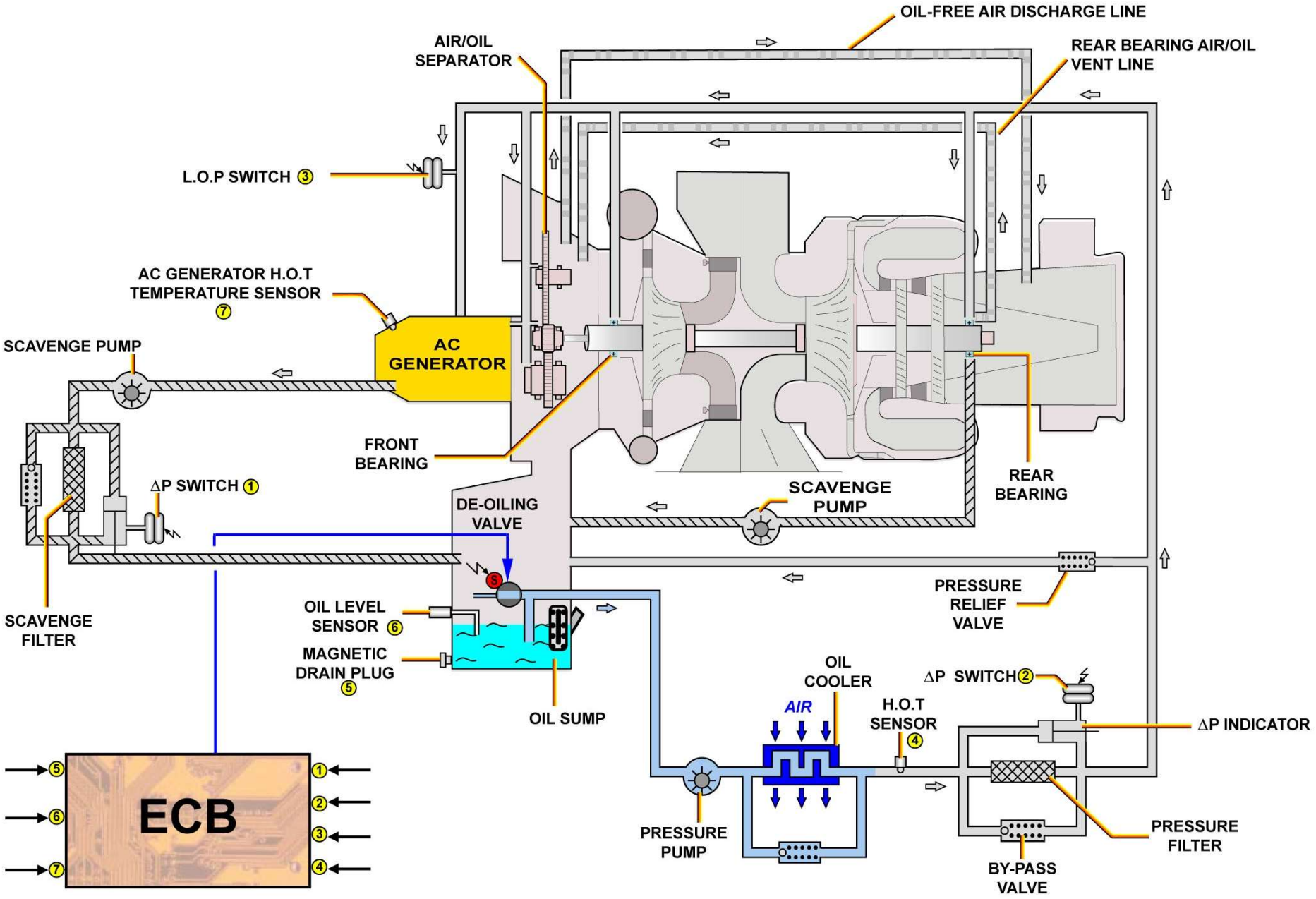
The only component of the oil system controlled by the Electronic Control Box (ECB) is the de-oiling valve.

DURING START

• De-oiling valve electrically controlled during start

•Above 55% APU speed, solenoid is de-energizes and de-oiling valve closes.

Especially during the cold start condition; the oil has a high viscosity. The de-oiling solenoid valve reduces the oil pressure pump load at any APU start by allowing air to enter the inlet of the oil supply pump. Above 55% APU speed, the ECB de-energizes the solenoid and the de-oiling valve closes.

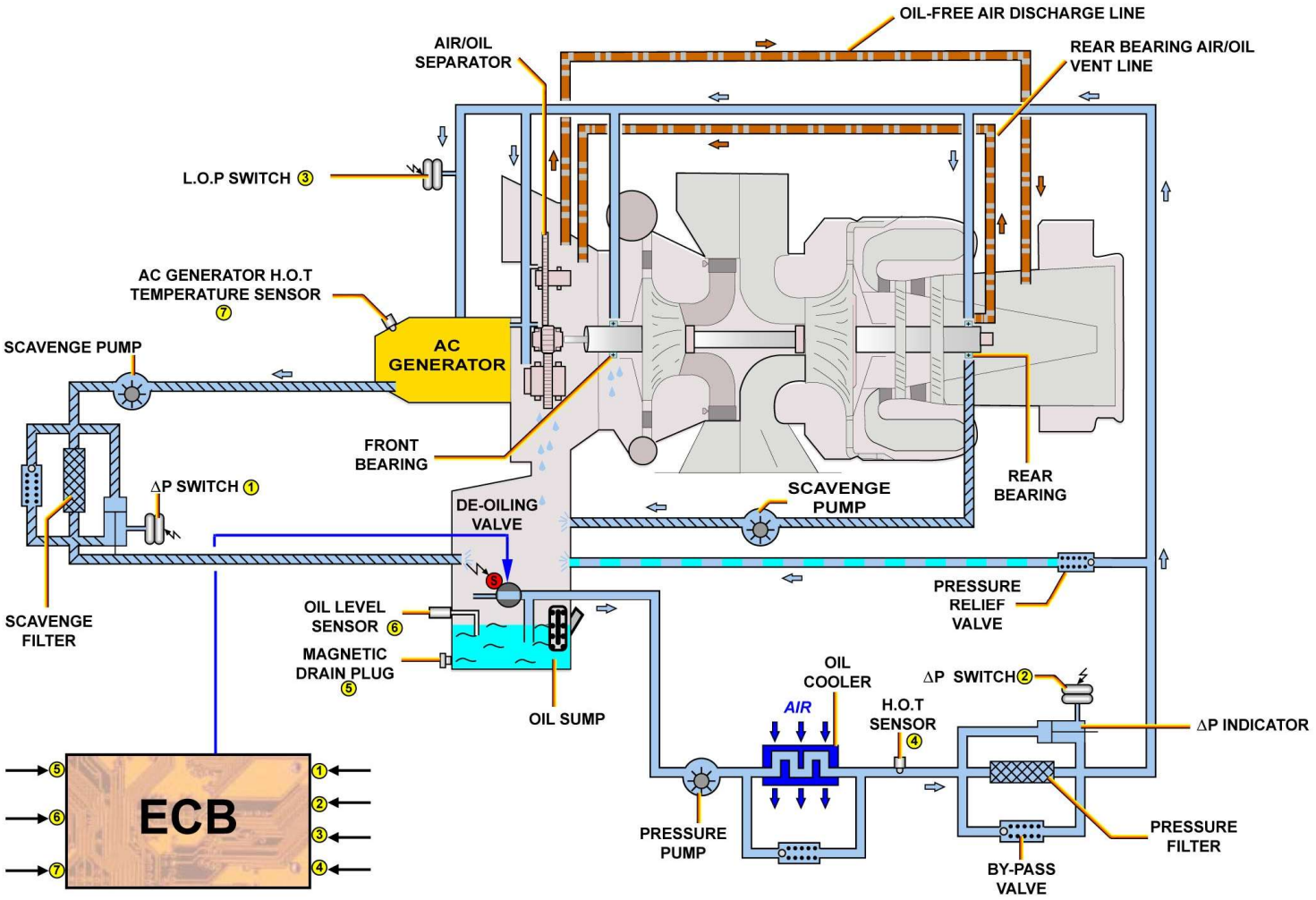

OIL-FREE AIR DISCHARGE LINE
AIR/OIL SEPARATOR
REAR BEARING AIR/OIL VENT LINE
L.O.P SWITCH 3
AC GENERATOR H.O.T TEMPERATURE SENSOR 7
AC GENERATOR
SCAVENGE PUMP
FRONT BEARING
REAR BEARING
ΔP SWITCH 1
DE-OILING VALVE
SCAVENGE PUMP
PRESSURE RELIEF VALVE
SCAVENGE FILTER
OIL LEVEL SENSOR 6
MAGNETIC DRAIN PLUG 5
OIL SUMP
OIL COOLER
AIR
ΔP SWITCH 2
H.O.T SENSOR 4
ΔP INDICATOR
ECB
PRESSURE PUMP
PRESSURE FILTER
BY-PASS VALVE

DURING SHUT DOWN

• APU shutdown

- To prevent coking of the oil remaining in the bearing chambers.

During the APU shutdown, the de-oiling solenoid valve prevents the coking of the oil remaining in the bearing chambers. Therefore the ECB opens the de-oiling solenoid valve during shut down between 90% and 7%



APU Air System Description and Operation

APU RUNNING AT 100% - BLEED NOT SELECTED

• Bleed control valve:
  - To supply the A/C pneumatic system
  - Fuel-operated
  - Diverter valve (supply A/C system or APU exhaust)

Bleed air supply to the A/C pneumatic system is controlled by a bleed control valve for delivery function. The fuel-operated bleed control valve is a diverter valve: either to the A/C system and/or the Auxiliary Power Unit (APU) exhaust.
NOTE: the hydraulic fluid is high pressure fuel from the Fuel Control Unit pressure regulator part with a pressure of approximately 250 psig.

BLEED CONTROL

• Quantity of air controlled by the IGVs
•IGVs fuel operated

The quantity of air necessary for the aircraft bleed users is controlled by the opening angles of the load compressor Inlet Guide Vanes (IGVs). The IGVs are moved by a fuel-powered actuator.

SURGE PROTECTION

• Done by bleed control valve
•Air discharged in the exhaust

Load compressor surge protection is done by the bleed control valve that discharges the excess of air in the exhaust.

OIL COOLING

• A gearbox-driven fan drives air from air inlet to the oil cooler
•Air discharged overboard from oil cooler
•Cooling fan incorporates a PMG to transiently supply the ECB

A gearbox-driven fan draws air from the inlet plenum and forces it to go through the oil cooler. After leaving the oil cooler, the air is discharged overboard. The cooling fan incorporates a Permanent Magnet Generator (PMG), which supplies a direct current to the Electronic Control Box (ECB), if the main supply is interrupted, for a maximum of 230ms.

COMPARTMENT COOLING

• Air from the gearbox-driven fan
•Natural convection supplied for ventilation when APU is not in operation

Air supplied by the fan, which is driven by one of the gears of the gearbox, is also used for the APU compartment cooling. The compartment cooling air is blown through a smaller duct attached to the fan discharge tube. Natural convection ventilates the APU compartment when the APU is not in operation.

PRESSURIZATION AND OIL VENT

• Pressurized air in the gearbox during operation from front and rear bearing seal buffering systems
•Air comes from power section compressor
•Gearbox vented to the APU exhaust
•Oil separated from vent air by an air/oil separator

Pressurized air enters the gearbox during operation from the front and rear bearing seal buffering systems. This air comes from the power section compressor. The gearbox is vented to the APU exhaust. The oil mist is separated from the vent air by an air-oil separator.

CONTROL

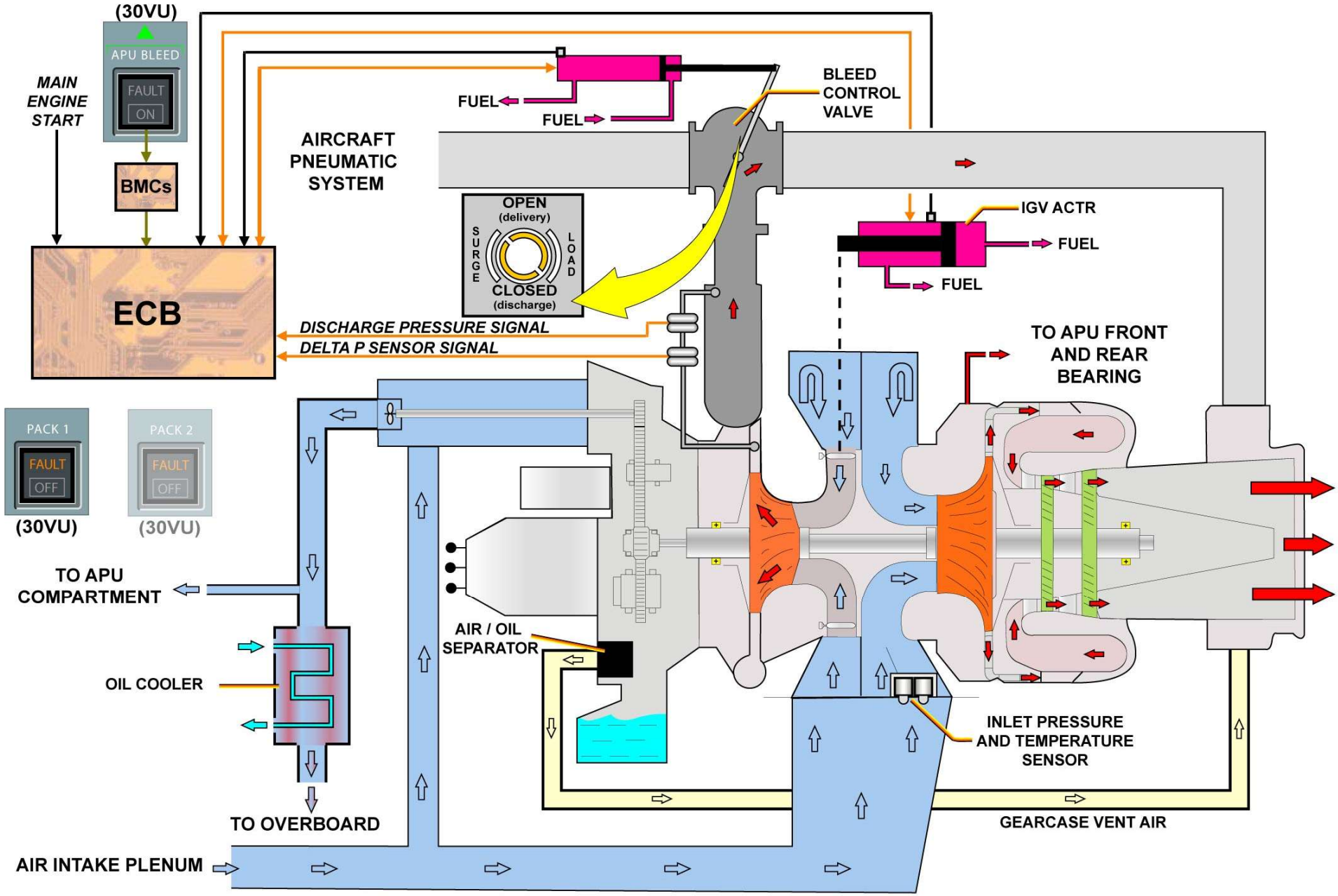
• ECB controls the air system:
  - Inlet pressure and temperature sensor
  - Load compressor discharge pressure
  - Command and feedback from fuel driven actuators

The ECB controls the air system using several parameters:
- signals from the APU inlet pressure and temperature sensor,
- signals from the load compressor discharge pressure sensor and the differential pressure sensor,
- command and feedback signals from the fuel driven actuators.

MONITORING

• The compressor discharge pressure sensor contains static pressure and differential pressure sensor
•ECB uses output to calculate compressor air flow
•For maintenance, bleed control valve equipped with visual position indicator

The compressor discharge pressure sensor is a unit, which contains a static pressure and a differential pressure sensor. It is located at the APU air intake plenum. The ECB uses the sensor output voltage for the calculation of the compressor air flow and to give the APU BLEED pressure indication for the APU page on the lower ECAM display unit. To help maintenance and troubleshooting, the bleed control valve has a visual position indicator.


(30VU)
APU BLEED
FAULT
ON
MAIN ENGINE START
BMCs
ECB
AIRCRAFT PNEUMATIC SYSTEM
FUEL
FUEL
BLEED CONTROL VALVE
OPEN
(delivery)
SURGE
LOAD
CLOSED
(discharge)
IGV ACTR
FUEL
FUEL
DISCHARGE PRESSURE SIGNAL
DELTA P SENSOR SIGNAL
TO APU FRONT AND REAR BEARING
PACK 1
FAULT
OFF
(30VU)
PACK 2
FAULT
OFF
(30VU)
TO APU COMPARTMENT
AIR / OIL SEPARATOR
OIL COOLER
INLET PRESSURE AND TEMPERATURE SENSOR
TO OVERBOARD
GEARCASE VENT AIR
AIR INTAKE PLENUM

APU RUNNING AT 100% - BLEED PUSHBUTTON ON

• APU BLEED P/B pushed:
    - ON light comes on
    - Signal to BCV and ECB

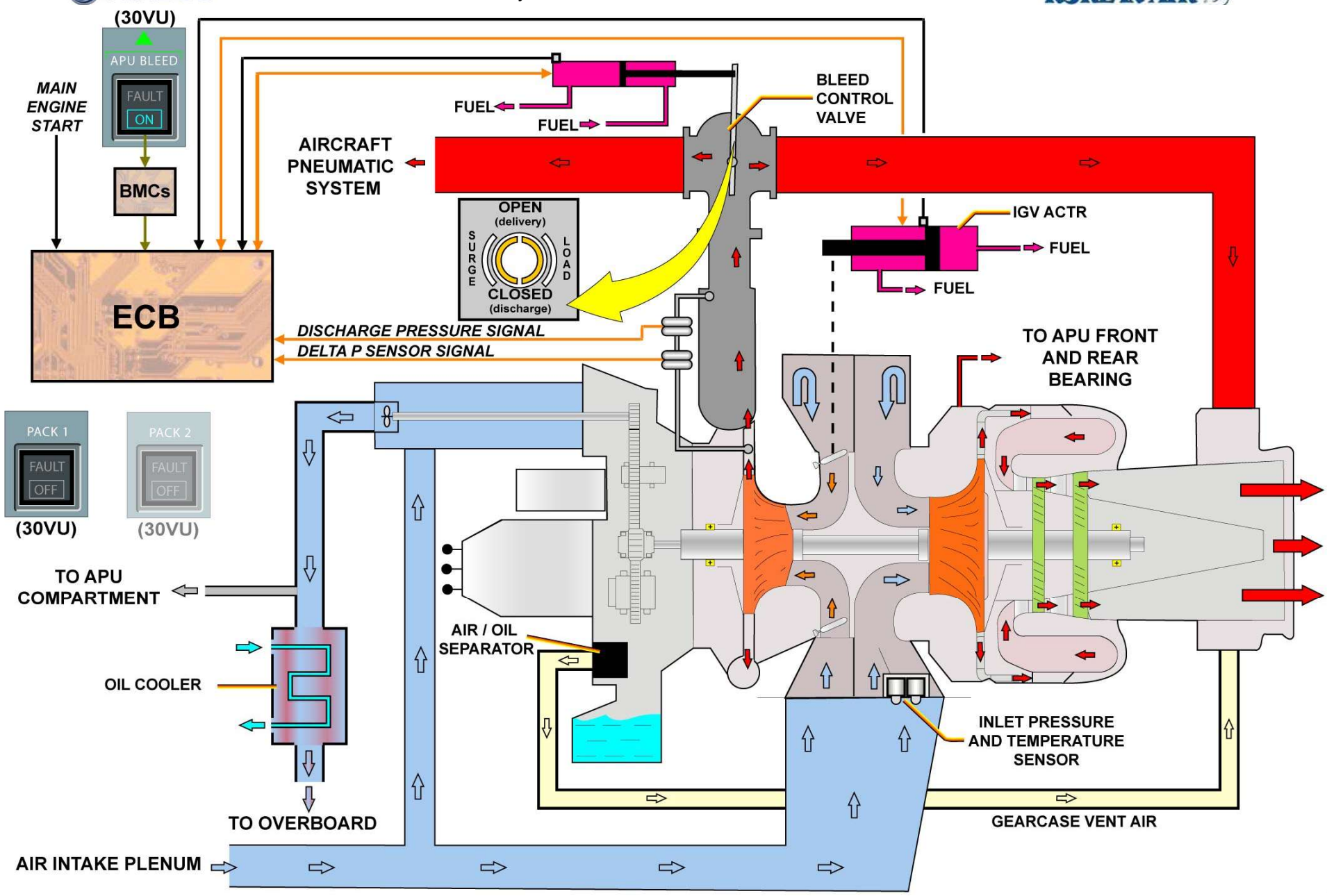
•BCV gives the position feedback to ECB

When the APU Bleed P/B is pushed, the blue ON light in the P/B comes on and a signal is sent to the two BMCs and to the ECB to open the Bleed Control Valve (BCV).

The BCV servo valve receives a command signal from the ECB to let the BCV open the duct for Aircraft Pneumatic System supply and to let bleed air flow into the supply duct.

To make sure that a pressure build-up occurs in the Aircraft Bleed supply duct, the ECB first commands the Bleed Control Valve (BCV) to the exhaust duct closed position and then modulates the BCV to prevent surge conditions.

The BCV uses an LVDT for position feedback transmission to the ECB.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INLET PRESSURE AND TEMPERATURE SENSOR
TO OVERBOARD
GEARCASE VENT AIR
AIR INTAKE PLENUM

APU RUNNING AT 100% - BLEED AND PACK PUSHBUTTON PUSHED

• ECB receives command signal from ECS control computer

- ECB sends an extend command signal to IGV actuator

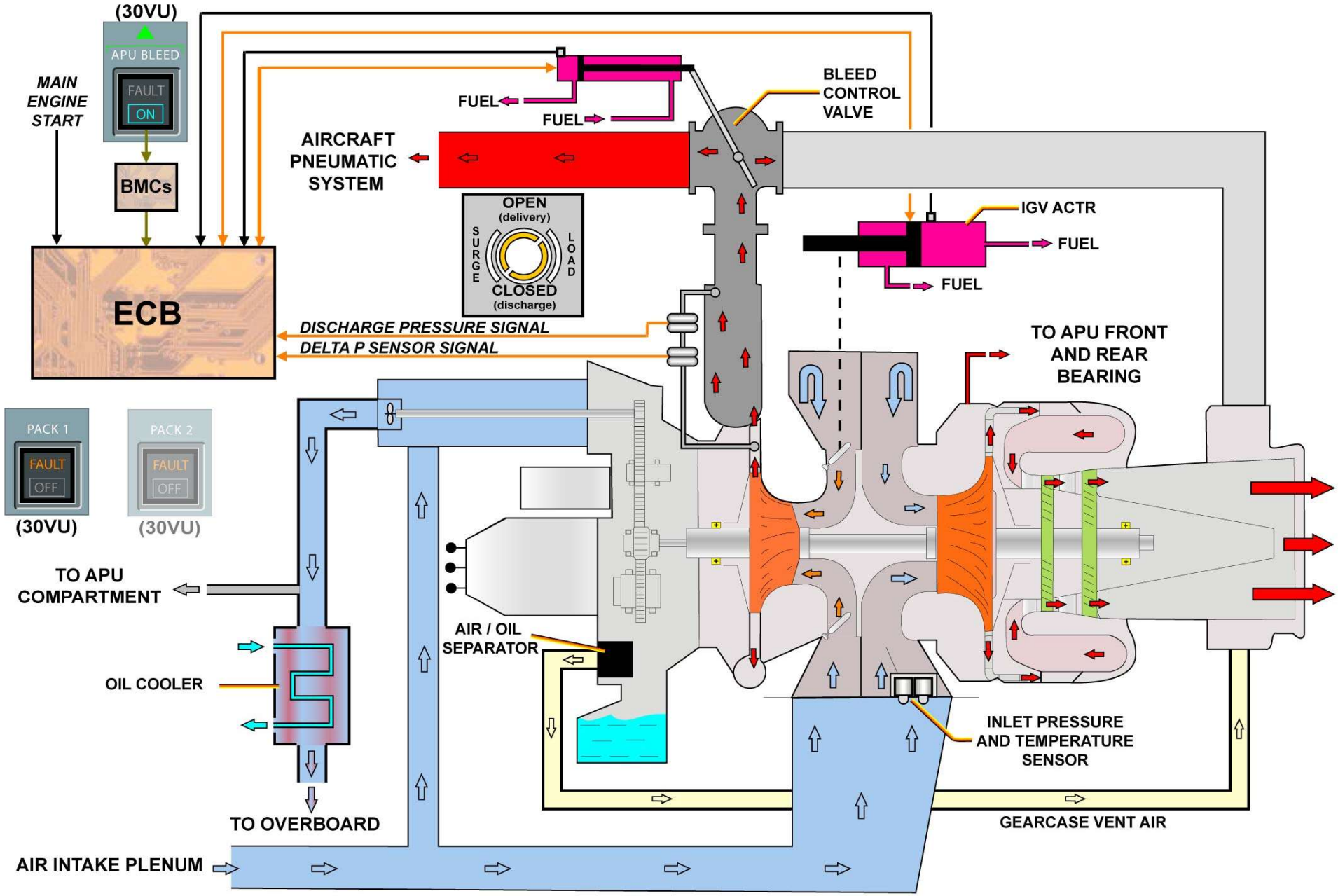
•ECB commands BCV to exhaust duct fully closed position

The ECB receives a command signal from the ECS Control Computer after the Pack P/B is pushed on the Cockpit overhead panel.

Because of this input signal, the ECB sends an extend command signal to the IGV-Actuator to drive the Inlet Guide Vanes into a more open position.

Because of this, more air from the APU Inlet Plenum will go through the IGVs into the Load Compressor Housing.

To make sure that the necessary bleed air mass flows from the APU to the ECS, the ECB commands the BCV to the exhaust duct fully closed position.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TO APU FRONT AND REAR BEARING
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FAULT
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TO APU COMPARTMENT
AIR / OIL SEPARATOR
OIL COOLER
INLET PRESSURE AND TEMPERATURE SENSOR
TO OVERBOARD
GEARCASE VENT AIR
AIR INTAKE PLENUM

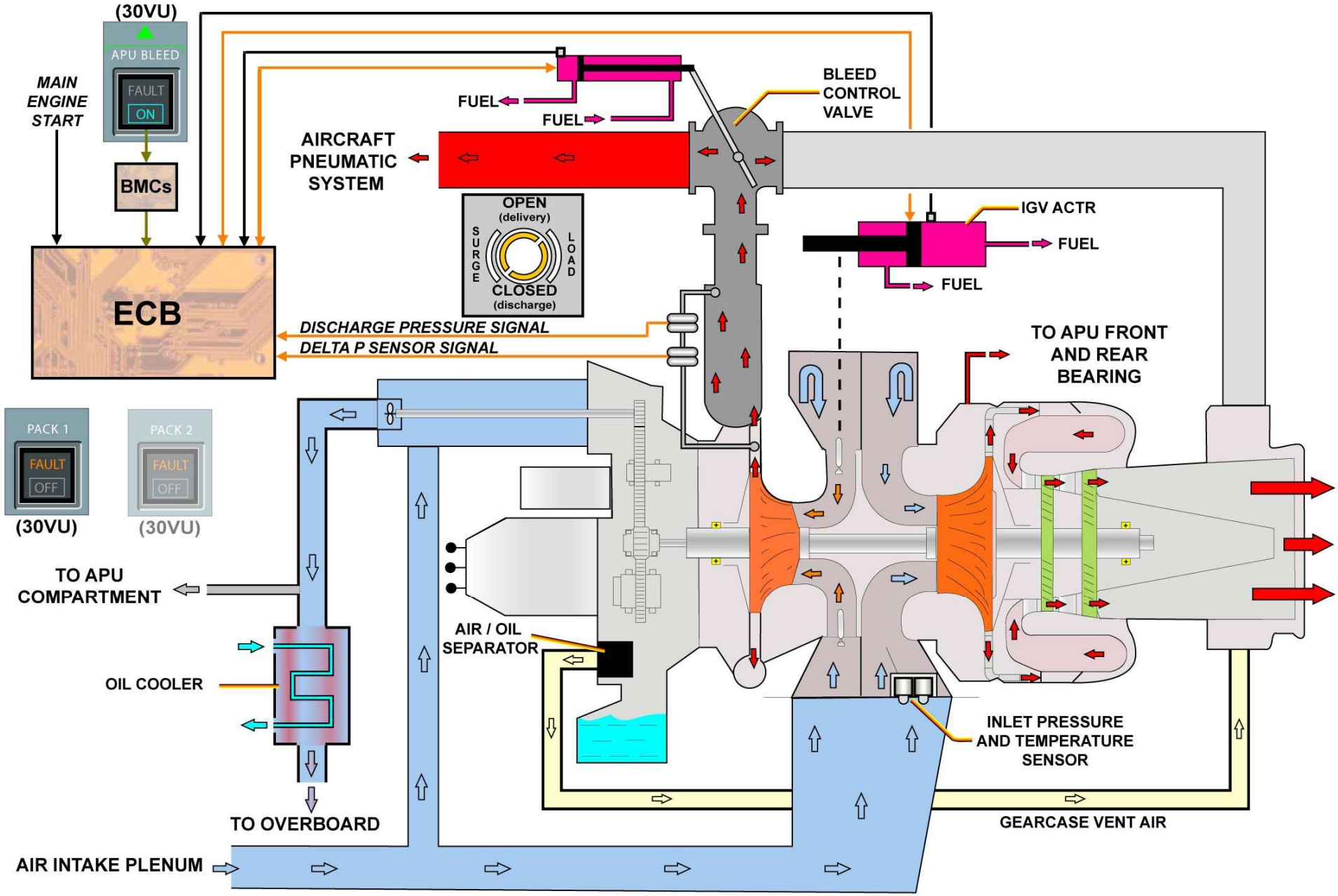
APU RUNNING AT 100% - BLEED AND MES SIGNAL INPUT TO ECB

•ECB receives a MES boost signal
•ECB commands IGV actuator to MAX retracted position
•BCV receives command signal from ECB
•At the end of engine start
- MES signal no longer applicable

•ECB commands IGV and BCV for bleed supply to ECS

When the engines of the aircaft are started, the ECB receives a Main Engine Start (MES) boost signal to increase the bleed pressure for engine start.

The ECB commands the IGV Actuator to the maximum extended position to drive the IGVs to the fully open position.
The BCV receives the command signal from the ECB to modulate and discharge a certain mass of air into the APU exhaust.
When the engine start sequence is completed, the MES signal is no longer applicable and the ECB commands the IGV actuator and the BCV to the necessary position for bleed supply of the ECS.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APU BLEED
FAULT
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MAIN ENGINE START
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TO APU COMPARTMENT
AIR / OIL SEPARATOR
OIL COOLER
INLET PRESSURE AND TEMPERATURE SENSOR
TO OVERBOARD
GEARCASE VENT AIR
AIR INTAKE PLENUM

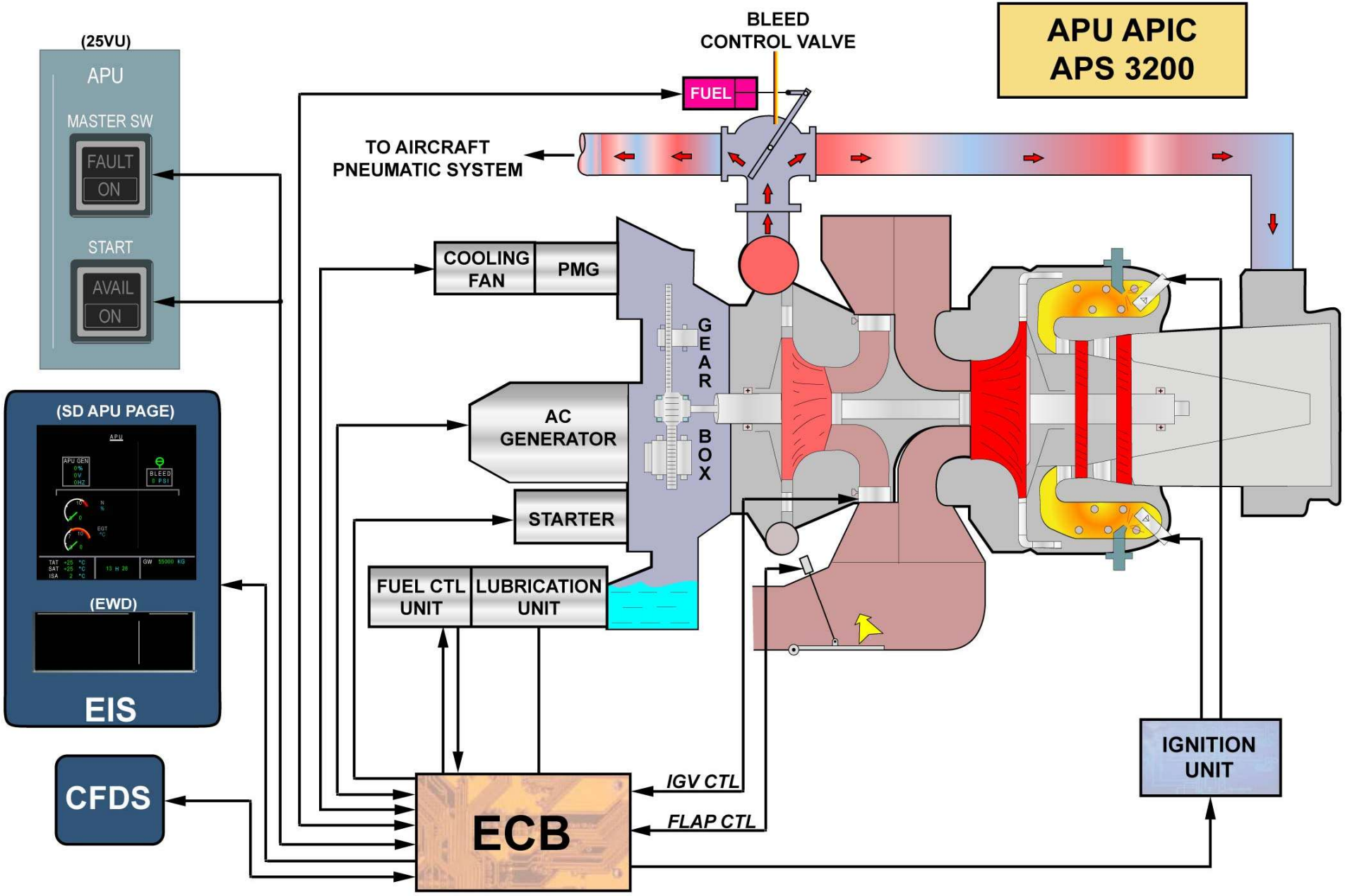
APU System Management Description and Operation

GENERAL

• System management for constant APU rotation speed
•Constant AC generator frequency output
•Protection from over temperature, load compressor surge
•Safe APU start, easier maintenance
•Management system controls power-up state, watch state, starting state, steady state, cool down state, shutdown state

The Auxiliary Power Unit (APU) system management and control keeps the APU rotation speed constant to obtain a constant AC generator frequency output, protects the power unit from over temperature, avoids load compressor surge, controls safe APU start and eases the APU maintenance. The APU management system controls the following sequences:

- power-up state,
- watch state,
- starting state,
- steady state,
- cool down state,
- shutdown sate.


APU APIC
APS 3200
(25VU)
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
BLEED
CONTROL VALVE
FUEL
TO AIRCRAFT
PNEUMATIC SYSTEM
COOLING
FAN
PMG
GEAR
BOX
AC
GENERATOR
STARTER
FUEL CTL
UNIT
LUBRICATION
UNIT
(SD APU PAGE)
(EWD)
EIS
CFDS
ECB
IGV CTL
FLAP CTL
IGNITION
UNIT

POWER-UP STATE

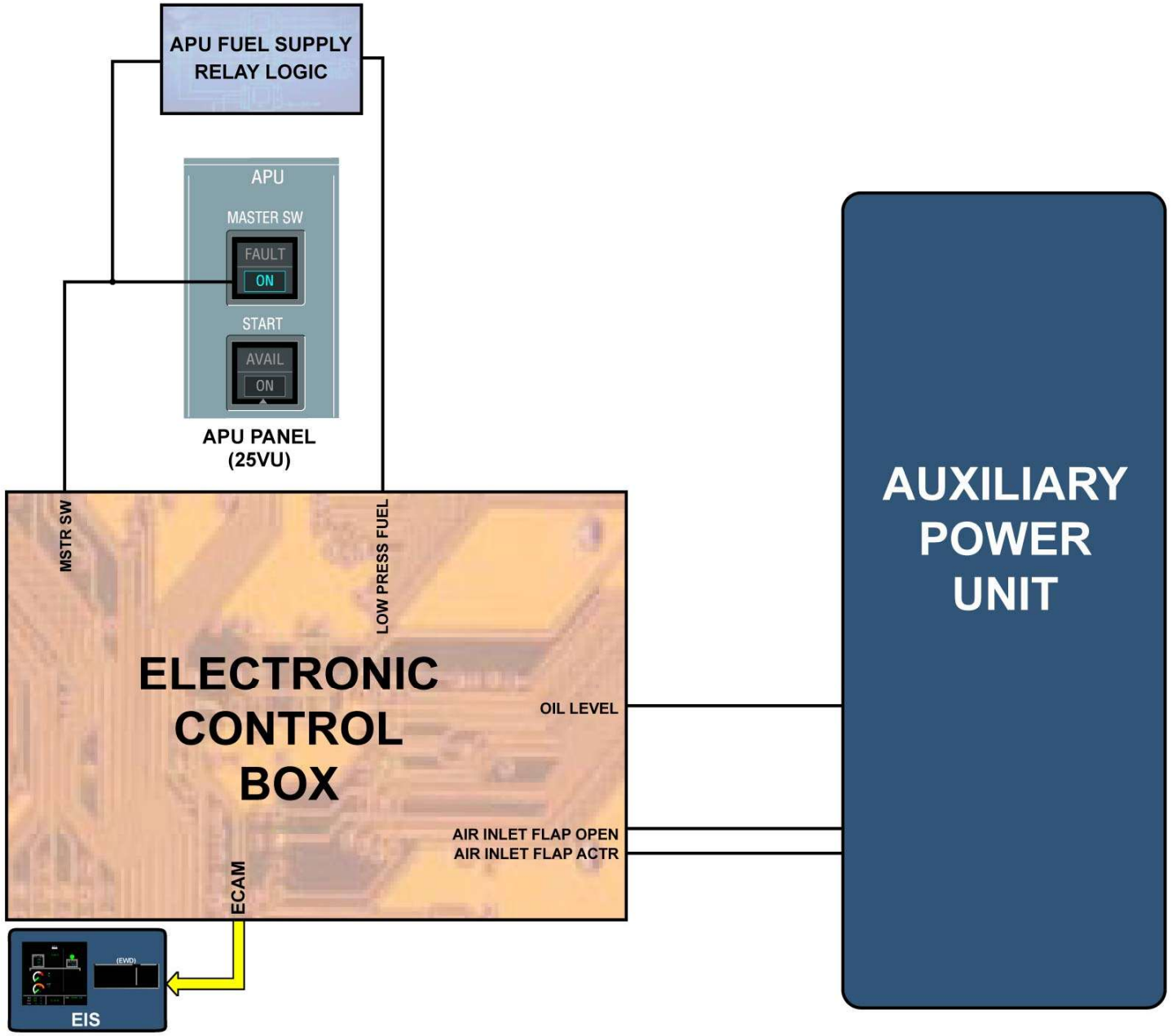
•MSTR SW ON

•Fuel LP valve open, fuel pump logic energized

•ECB controls air intake flap and initiates power-up test

When the APU MASTER SWitch is set to ON, the APU fuel Low Pressure (LP) valve opens and the APU fuel pump logic is energized. The Electronic Control Box (ECB) controls the opening of the air intake flap and initiates a power-up test:

- test of On Board Replaceable Module (OBRM), Read Only Memory (ROM) checksum, Random Access Memory (RAM) read/write,
- test of speed circuit, oil level, discrete and analog outputs,
- on the lower ECAM display unit the APU page is shown.

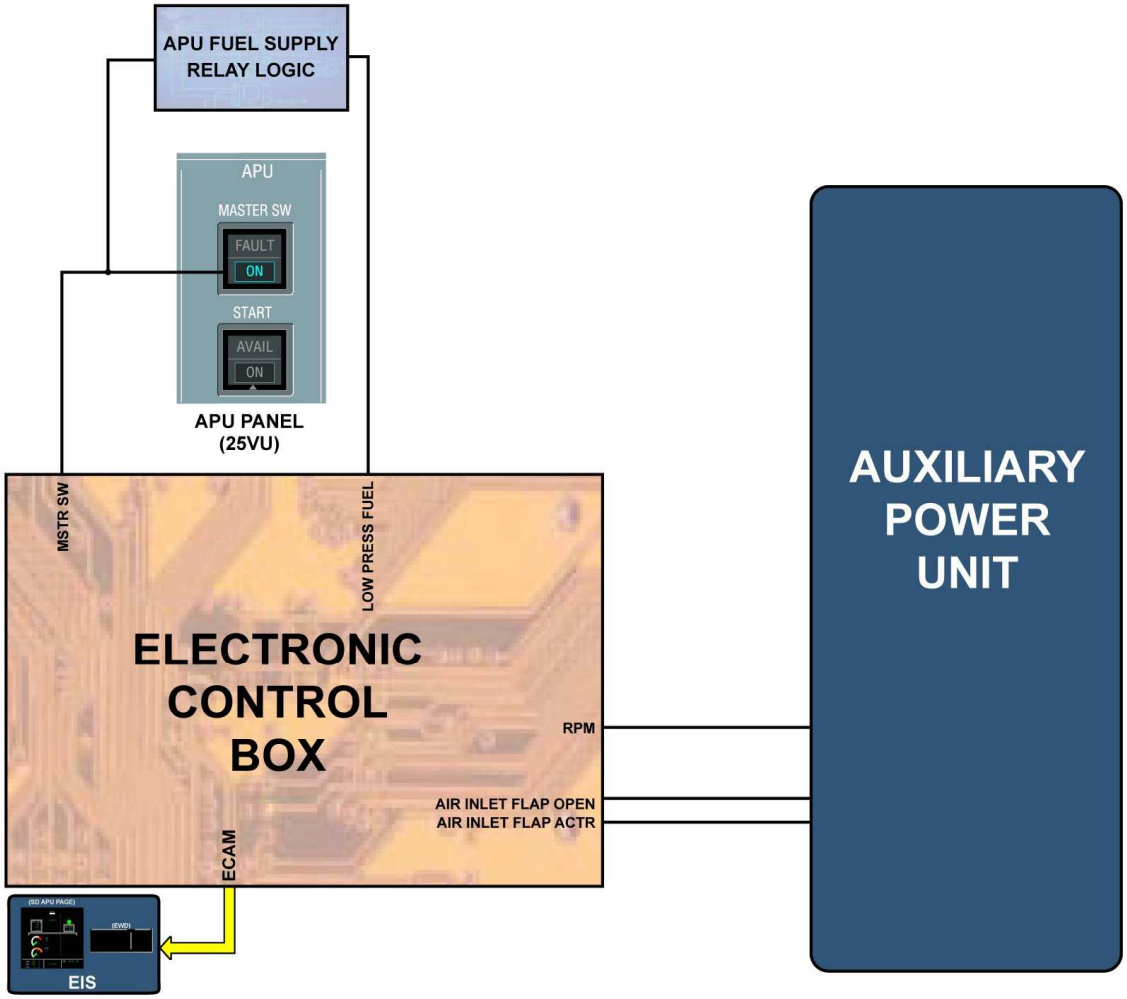

APU FUEL SUPPLY RELAY LOGIC
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
APU PANEL (25VU)
MSTR SW
LOW PRESS FUEL
ELECTRONIC CONTROL BOX
OIL LEVEL
AIR INLET FLAP OPEN
AIR INLET FLAP ACTR
ECAM
EIS
AUXILIARY POWER UNIT

WATCH AND START PREPARATION STATE

• After power-up test, ECB initiates the watch state

•If no prohibitive conditions and rotation speed ≤7% rpm, the ECB enters start preparation

After completion of the power-up state, the ECB automatically enters the watch state. Upon receipt of the start command, provided that there are no prohibitive conditions and rotation speed is less than or equal to 7% rpm, the ECB enters the start preparation state.



STARTING STATE

• APU START P/BSW pressed

•APU AVAILable light activation

The starting state begins when the APU START P/BSW is pressed and continues until APU AVAILable light activation.

START P/B PRESSED + 100 MS

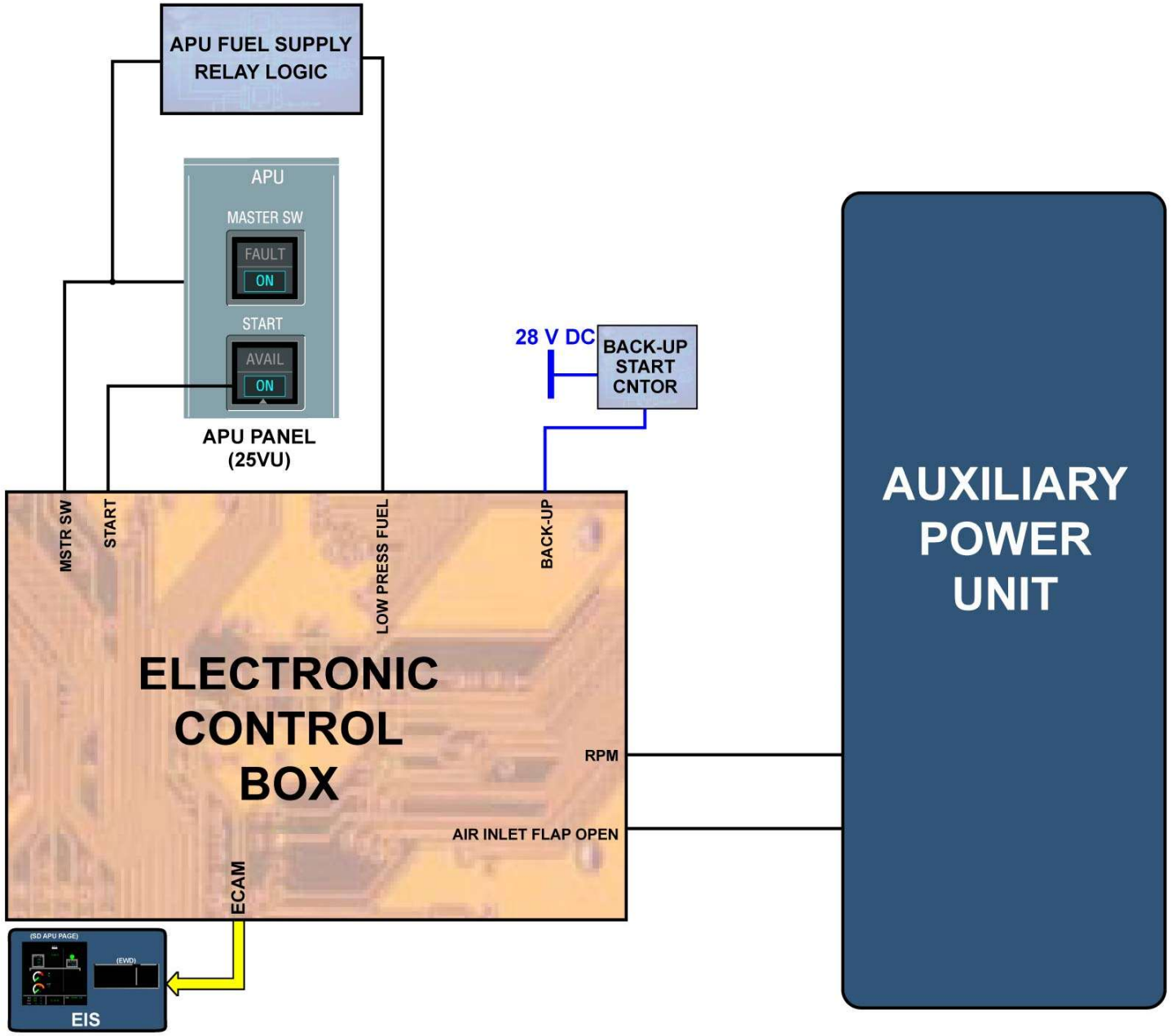
• Start sequence after START P/BSW pushed in

•If stop signal during start sequence, there is a shutdown without cool down

•Backup start contactor energized by ECB

When the START P/BSW has been pressed in, the ECB initiates the start sequence and energizes the backup start contactor.

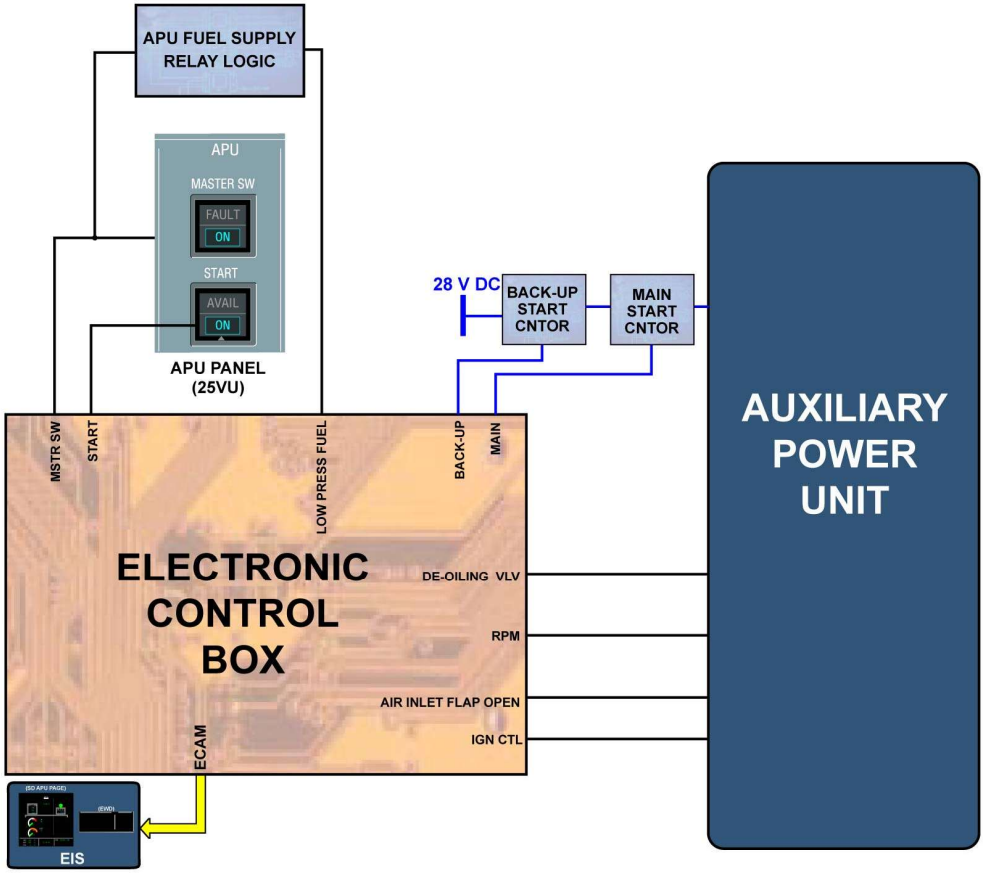
The receipt of a stop signal at any time during the starting state leads to a shutdown without any cool down period.


APU FUEL SUPPLY RELAY LOGIC
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
APU PANEL (25VU)
28 V DC
BACK-UP START CNTOR
AUXILIARY POWER UNIT
MSTR SW
START
LOW PRESS FUEL
BACK-UP
ELECTRONIC CONTROL BOX
RPM
AIR INLET FLAP OPEN
ECAM
(SD APU PAGE)
(EWD)
EIS

BACKUP START CONTACTOR SUPPLIED + 1.5 S

• Components activated by ECB:
  - De-oiling valve
  - Ignition unit
  - Main start contactor

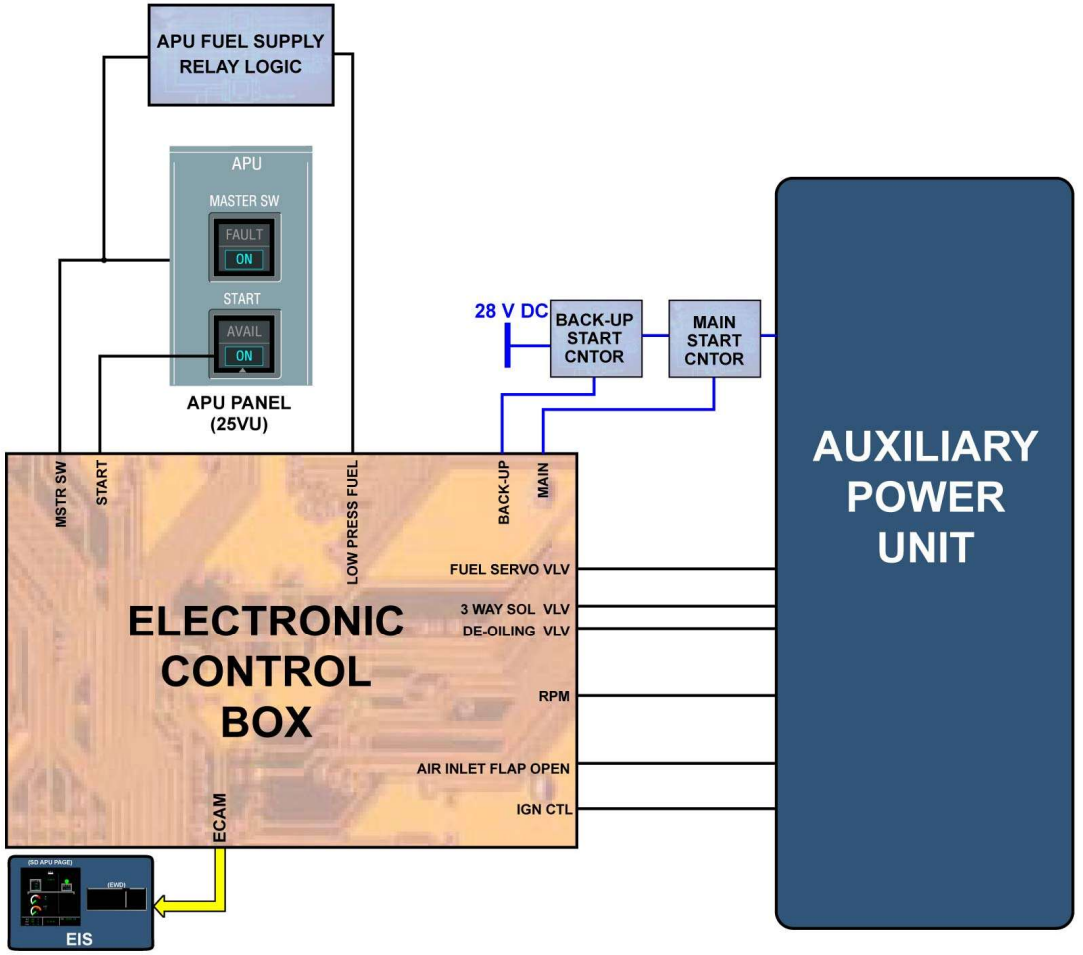
The components activated by the ECB are:
- the gearbox de-oiling valve,
- the ignition unit,
- the main start contactor.



ROTATION SPEED N > 3% RPM

• Components activated by ECB:
  - 3-way solenoid valve
  - Fuel servovalve

The components activated by the ECB are:
- the 3-way solenoid valve for the High Pressure (HP) fuel ON/OFF function,
- the fuel servovalve for the fuel metering function.

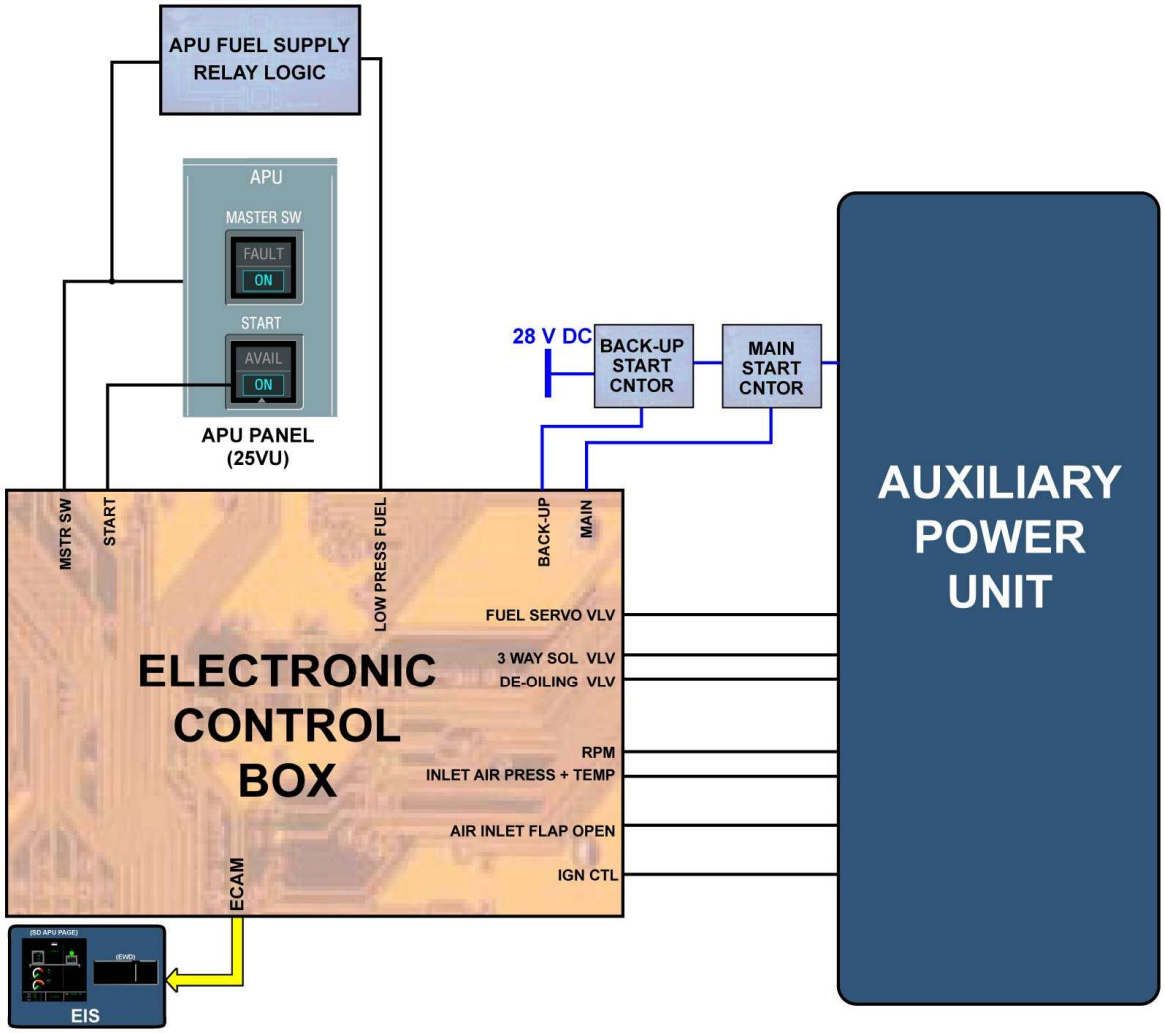


ROTATION SPEED N > 5% RPM

• Fuel flow controlled and regulated

During starting, fuel flow is controlled under the following programs:

- begin manifold fill algorithm,
- open loop fuel schedule



DELTA EGT > 10 º C

• Acceleration control to 100% rpm

The initiated acceleration is controlled to 100% rpm.

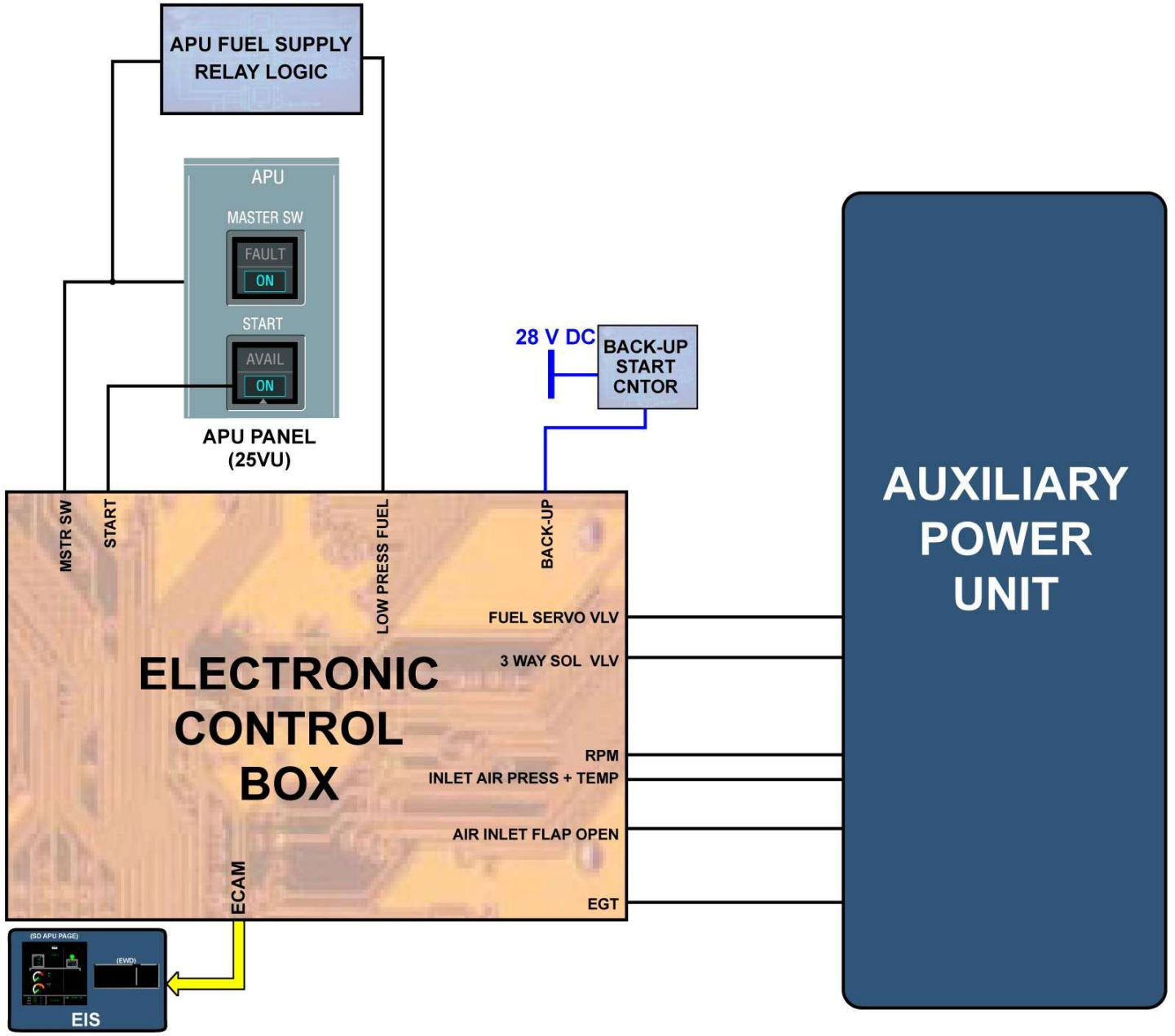
ROTATION SPEED N > 55% RPM

• ECB de-energizes:

- Ignition unit
- De-oiling valve
- Main start contactor

The ECB de-energizes:

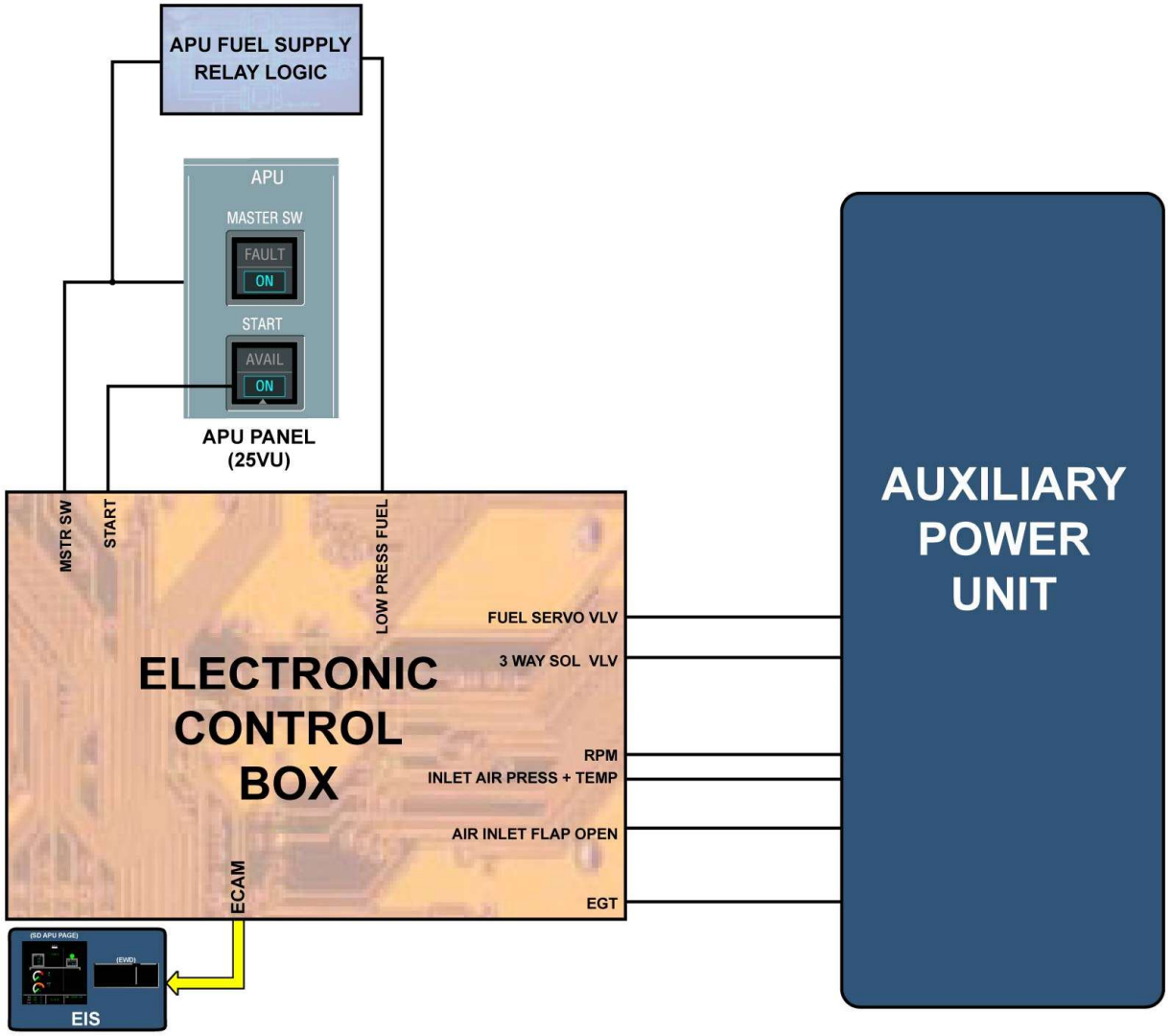
- the ignition unit,
- the gearbox de-oiling valve,
- the main start contactor.


APU FUEL SUPPLY RELAY LOGIC
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
APU PANEL (25VU)
28 V DC
BACK-UP START CNTOR
AUXILIARY POWER UNIT
MSTR SW
START
LOW PRESS FUEL
BACK-UP
ELECTRONIC CONTROL BOX
FUEL SERVO VLV
3 WAY SOL VLV
RPM
INLET AIR PRESS + TEMP
AIR INLET FLAP OPEN
EGT
ECAM
(SD APU PAGE)
(EWD)
EIS

ROTATION SPEED N > 55% RPM + 5 S

• Backup start contactor de-energized

The backup start contactor is de-energized



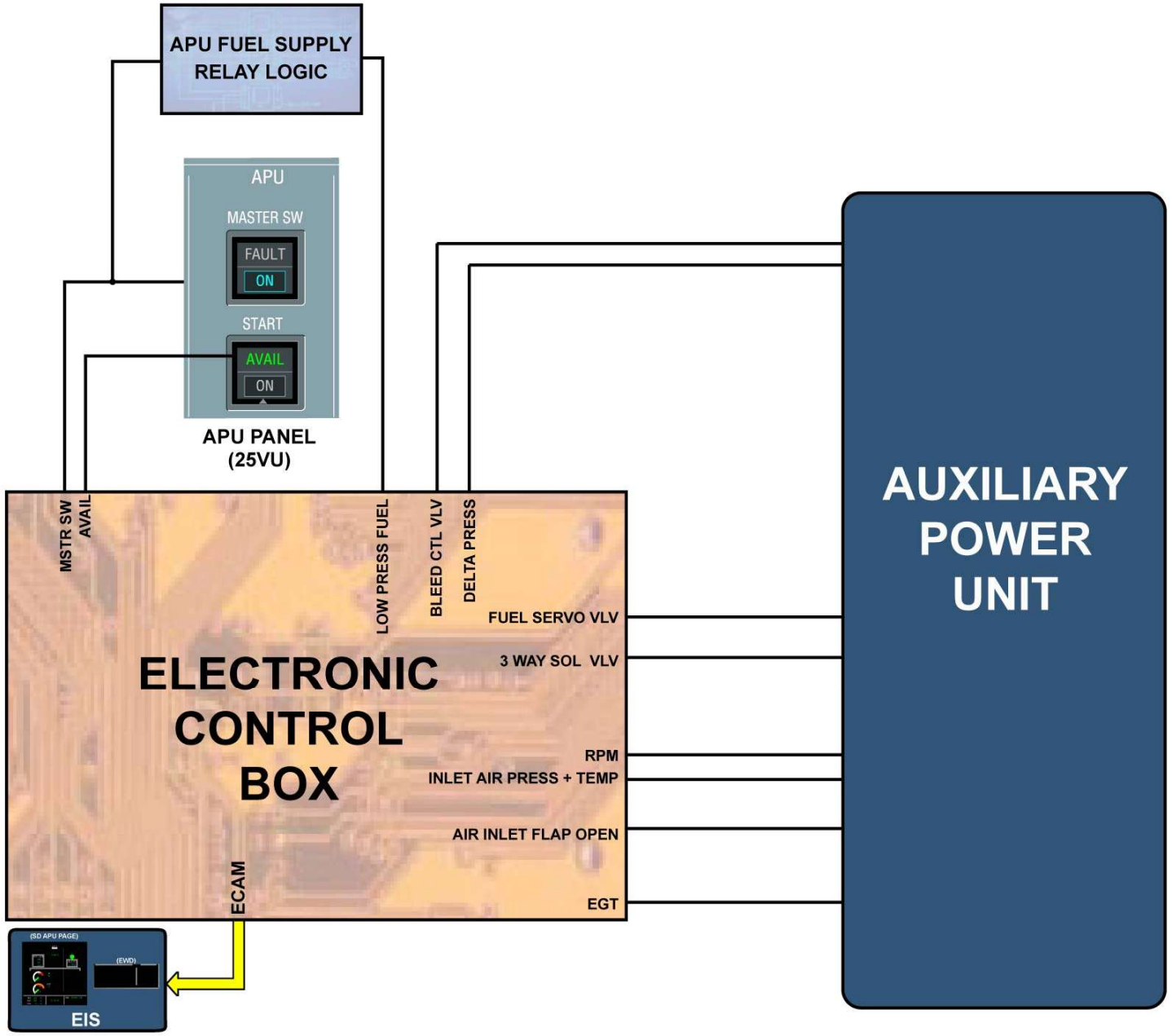
ROTATION SPEED N > 95% RPM

• ECB functions:

- If APU Bleed selected then Surge control and IGV control loops are activated
- APU AVAIL signal energized
- Start in progress output de-activation
- Steady state speed control loop activated
- Enter run state

The ECB functions are:

- surge control and IGV control loops activation,
- APU AVAIL signal activation,
- start in progress output de-activation,
- steady state speed control loop activation,
- enter run state.


APU FUEL SUPPLY RELAY LOGIC
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
APU PANEL (25VU)
MSTR SW AVAIL
LOW PRESS FUEL
BLEED CTL VLV
DELTA PRESS
FUEL SERVO VLV
3 WAY SOL VLV
ELECTRONIC CONTROL BOX
RPM
INLET AIR PRESS + TEMP
AIR INLET FLAP OPEN
EGT
ECAM
(SD APU PAGE)
(EWD)
EIS
AUXILIARY POWER UNIT

STEADY STATE

• Control of the speed, the load compressor operation, and monitoring of EGT

In steady state the ECB controls the speed, the load compressor operation, and monitors the Exhaust Gas Temperature (EGT).

SPEED CONTROL

• Function to keep APU speed constant

•Metering fuel flow following air inlet pressure and temperature

This function keeps the rotation speed of the APU rotating assembly constant, whatever the load applied. This is achieved by metering the fuel flow, which varies with the air inlet pressure and temperature.

LOAD COMPRESSOR CONTROL

• Open Inlet Guide Vanes (IGVs) according to Bleed air demand from A/C: ECS or MES

•Function to avoid compressor surge

•Control and meter of the bleed control valve position according to inlet temperature, and differential and discharge pressure

•If surge condition, the bleed control valve positioned to discharge air to exhaust

This function opens the Inlet Guide Vanes (IGVs) according to the bleed air demand from the A/C, ECS or MES. Protection against load compressor surge is achieved by controlling and reading the position of the bleed control valve, according to the inlet temperature, and differential and discharge pressure signals of the load compressor (DELTA P/P ratio). If the ECB detects a surge condition, the bleed control valve is positioned to discharge air to the exhaust.

NOTE 1: In case of failure of the load compressor control, the IGVs are closed and the bleed control valve is fully opened to discharge.

NOTE 2: In case of detected reverse flow operation, the APU is automatically shut down by the ECB.

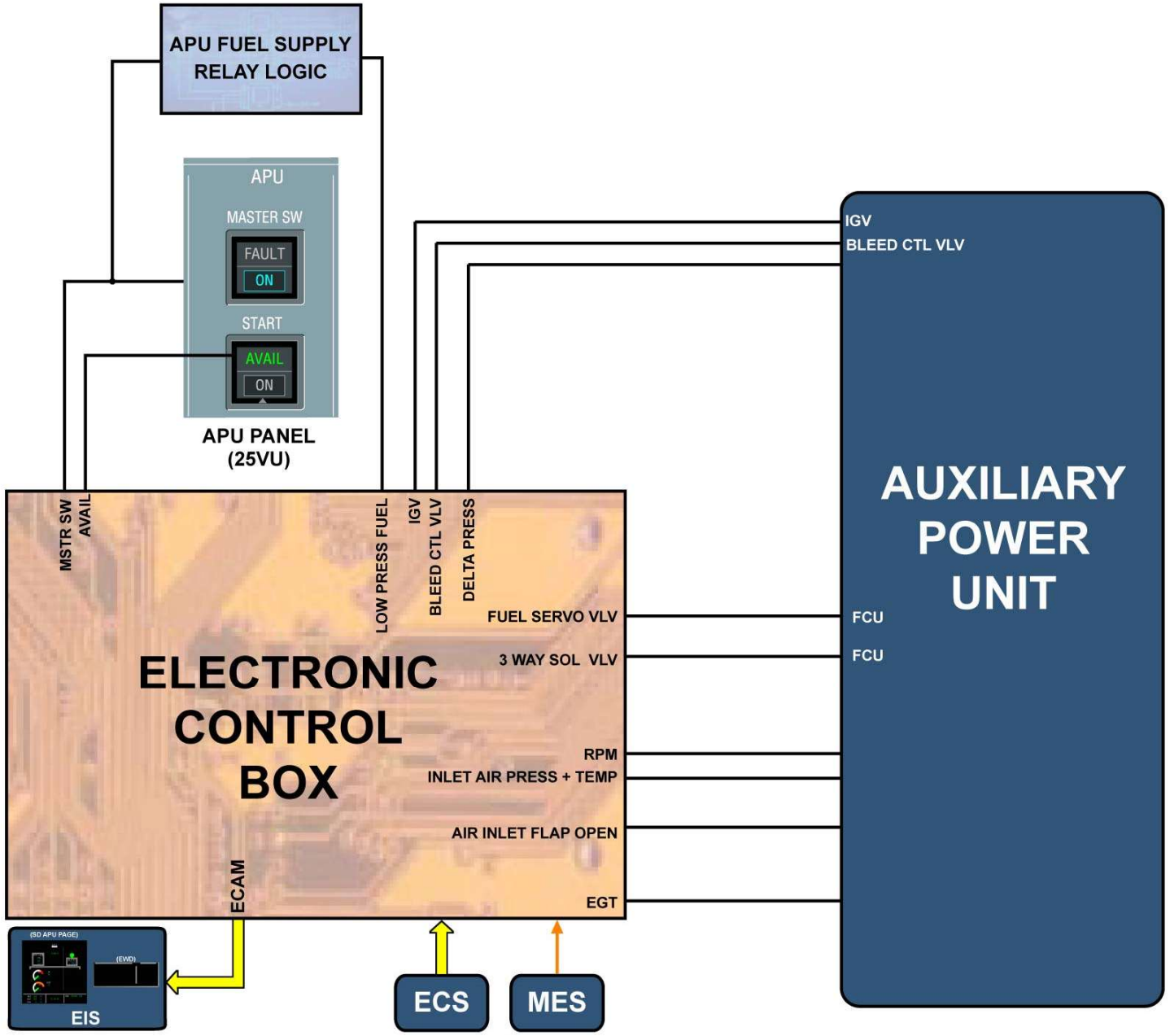
EGT CONTROL

• Function to avoid over temperature

•Cutback of the IGV position

This function avoids APU over temperature by controlling the Inlet Guide Vane (IGV) position to closed. Thus, the pneumatic load is first reduced to give priority to the electrical load. This is achieved by controlling the position of the IGVs to the closed position as a function of the EGT as long as the over temperature condition is present.

NOTE: In case of IGV control failure, the IGVs are closed.


APU FUEL SUPPLY RELAY LOGIC
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
APU PANEL (25VU)
MSTR SW AVAIL
LOW PRESS FUEL
IGV
BLEED CTL VLV
DELTA PRESS
ELECTRONIC CONTROL BOX
ECAM
FUEL SERVO VLV
3 WAY SOL VLV
RPM
INLET AIR PRESS + TEMP
AIR INLET FLAP OPEN
EGT
IGV
BLEED CTL VLV
AUXILIARY POWER UNIT
FCU
FCU
(SD APU PAGE)
(EWD)
EIS
ECS
MES

COOLDOWN STATE

• MSTR SW P/B OFF

•Pneumatic load is removed

•120 s cool down cycle for a low stabilized temperature before shutdown

At stop command MASTER SW OFF, the pneumatic load is removed, i.e. the IGVs are closed, the bleed control valve positioned to discharge, the AC generator may still be loaded, then the engine goes into a 120 s cool down cycles. This function runs the APU at a low stabilized temperature before normal shutdown.

NORMAL SHUTDOWN

• MSTR SW P/B OFF

•Without APU bleed air, there is an APU shutdown immediately

•Fuel supply stopped and APU deceleration

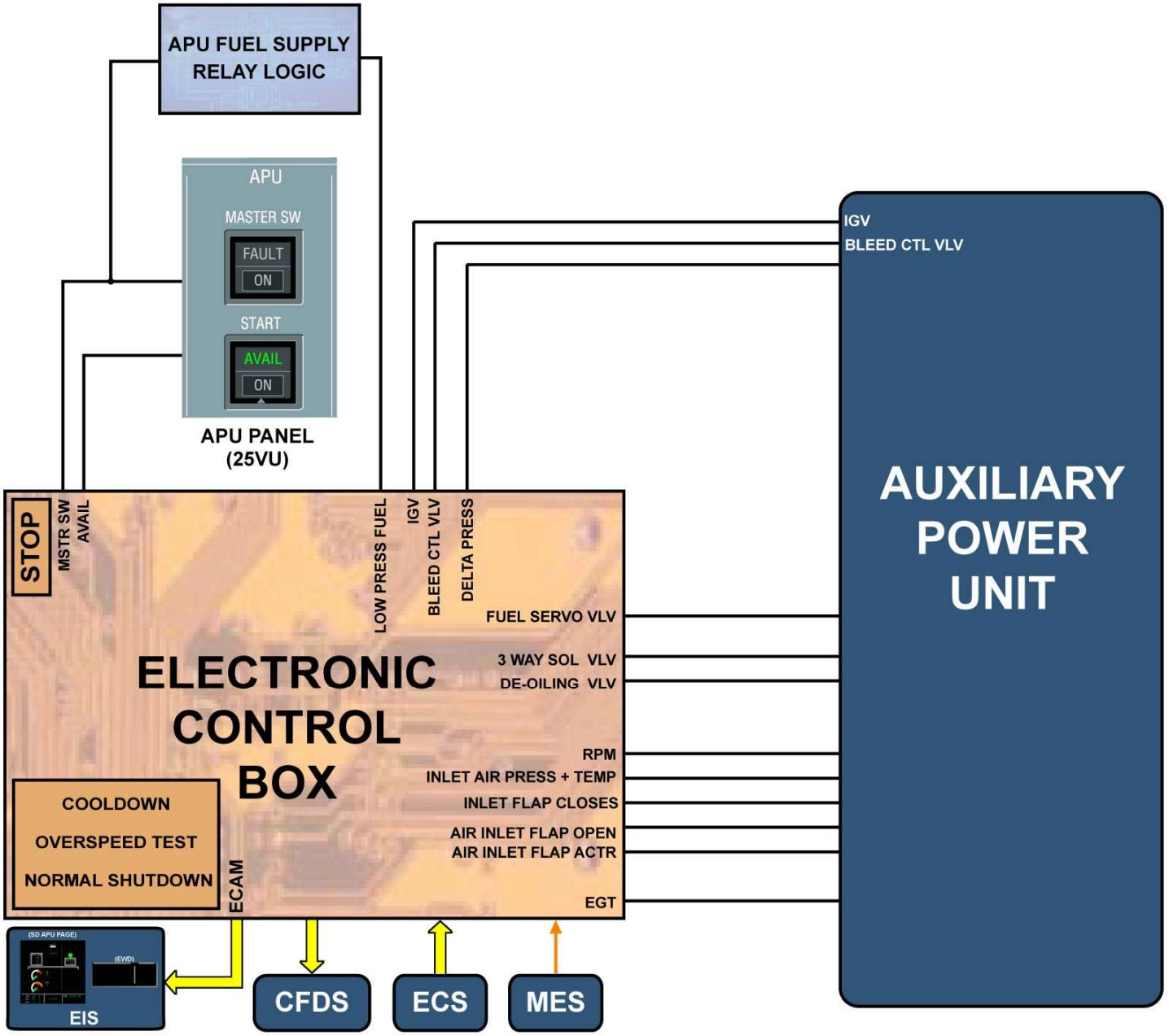
•AVAIL indication goes off

•AC generator de-energized

•When N< 90%, the de-oiling solenoid valve opens

•When N< 7%, the air intake flap closes

An APU normal shutdown is initiated when the MASTER SW P/B is released out. If the APU bleed air is not selected, the APU shuts down immediately. The normal shutdown signal stops the fuel supply. This causes the APU to decelerate. The AVAIL indication goes off and the AC generator de-energizes. When the speed is less than 90% rpm, the gearbox de-oil solenoid valve opens. When the speed is less than 7% rpm, the air intake flap is controlled to fully close and the de-oiling solenoid valve is de-energized to close.


APU FUEL SUPPLY RELAY LOGIC
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
APU PANEL (25VU)
IGV
BLEED CTL VLV
AUXILIARY POWER UNIT
STOP
MSTR SW AVAIL
LOW PRESS FUEL
IGV
BLEED CTL VLV
DELTA PRESS
FUEL SERVO VLV
3 WAY SOL VLV
DE-OILING VLV
ELECTRONIC CONTROL BOX
RPM
INLET AIR PRESS + TEMP
INLET FLAP CLOSES
AIR INLET FLAP OPEN
AIR INLET FLAP ACTR
EGT
COOLDOWN
OVERSPEED TEST
NORMAL SHUTDOWN
ECAM
(SD APU PAGE)
(EWD)
EIS
CFDS
ECS
MES

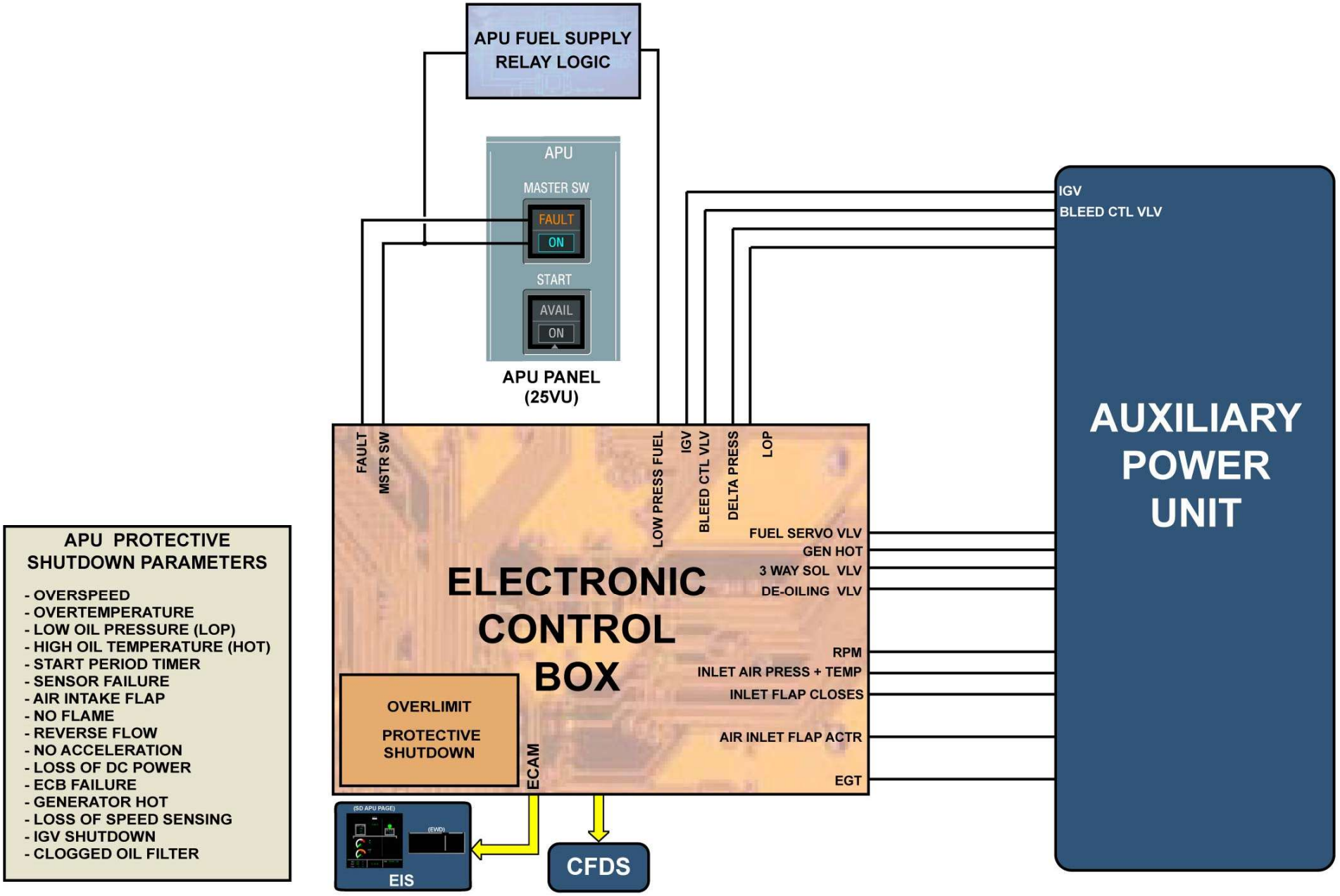
PROTECTIVE SHUTDOWN

• If abnormal parameters detected, immediate shutdown without time delay even with APU bleed air ON

•ECB protective shutdown parameters

When the ECB is powered, it controls the APU starting and running phases. If an abnormal parameter is detected, it initiates an immediate shutdown without time delay, even if the APU bleed air system is used. The ECB protective shutdown parameters are:

- over speed,
- over temperature
- Low Oil Pressure (LOP),
- High Oil Temperature (HOT),
- start period timer,
- sensor failure,
- air intake flap,
- no flame,
- reverse flow,
- no acceleration,
- loss of DC power,
- ECB failure,
- generator HOT
- loss of speed sensing,
- IGV shutdown,
- oil filter clogged.



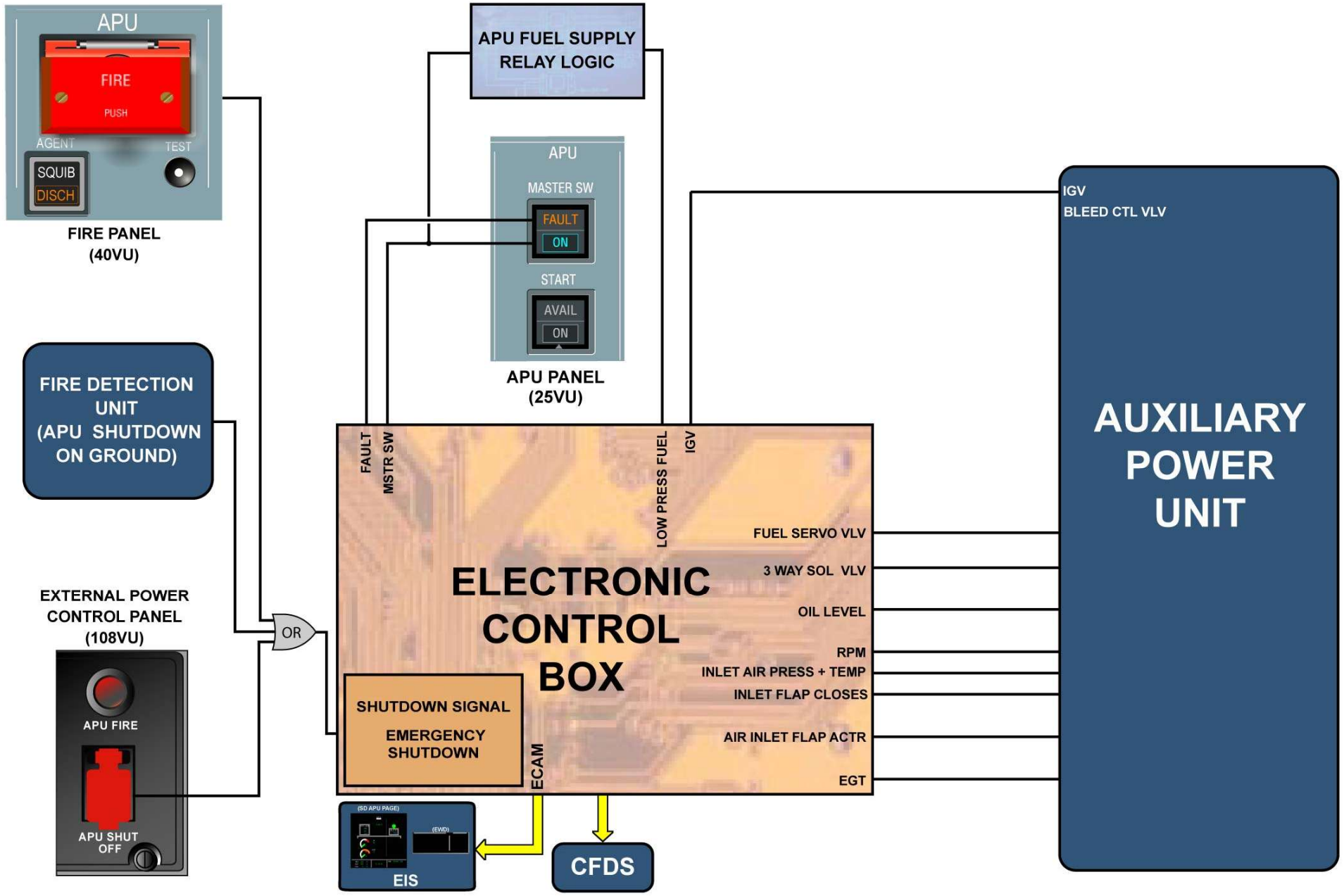
APU PROTECTIVE SHUTDOWN PARAMETERS

- OVERSPEED
- OVERTEMPERATURE
- LOW OIL PRESSURE (LOP)
- HIGH OIL TEMPERATURE (HOT)
- START PERIOD TIMER
- SENSOR FAILURE
- AIR INTAKE FLAP
- NO FLAME
- REVERSE FLOW
- NO ACCELERATION
- LOSS OF DC POWER
- ECB FAILURE
- GENERATOR HOT
- LOSS OF SPEED SENSING
- IGV SHUTDOWN
- CLOGGED OIL FILTER

EMERGENCY SHUTDOWN

• When the APU FIRE P/B in the cockpit is released out
•When the APU SHUT OFF P/B is pressed on the external power control panel
•Automatic emergency shutdown by ECB when an APU fire is detected on ground
•APU shutdown immediately without time delay even with APU bleed air ON

The ECB initiates an emergency shutdown when either the APU FIRE P/B, which is located in the cockpit, is released out, or when the APU SHUT OFF pushbutton, which is located on the external power receptacle panel, is pressed. The ECB receives automatically an emergency shutdown signal when an APU FIRE is detected on ground by the APU Fire Detection Unit. The APU shuts down immediately without time delay, even if the APU bleed air system is used.


APU
FIRE
PUSH
AGENT
TEST
SQUIB
DISCH
FIRE PANEL
(40VU)
APU FUEL SUPPLY
RELAY LOGIC
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
APU PANEL
(25VU)
FIRE DETECTION
UNIT
(APU SHUTDOWN
ON GROUND)
EXTERNAL POWER
CONTROL PANEL
(108VU)
APU FIRE
APU SHUT
OFF
OR
FAULT
MSTR SW
LOW PRESS FUEL
IGV
ELECTRONIC
CONTROL
BOX
SHUTDOWN SIGNAL
EMERGENCY
SHUTDOWN
ECAM
FUEL SERVO VLV
3 WAY SOL VLV
OIL LEVEL
RPM
INLET AIR PRESS + TEMP
INLET FLAP CLOSES
AIR INLET FLAP ACTR
EGT
(SD APU PAGE)
(EWD)
EIS
CFDS
IGV
BLEED CTL VLV
AUXILIARY
POWER
UNIT

ECB Interfaces

POWER SUPPLY
• ECB electrically supplied by:
- main control relay,
- at least one battery,
- A/C DC network
- and PMG 28 V DC

The Electronic Control Box (ECB) is electrically supplied, through the Auxiliary Power Unit (APU) MAIN control relay, by at least one of the A/C batteries, the A/C DC network or transiently from the 28 V DC Permanent Magnet Generator (PMG).

MASTER SWITCH P/B
• Discrete supply or stop signal to the ECB
The APU MASTER SWitch sends a discrete supply or stop signal to the ECB. The ECB sends a discrete signal to the FAULT light when an automatic or emergency shutdown occurs or a power-up test fails.

AIR INTAKE FLAP
• Open or closed position input and output signal to the ECB
The ECB sends a power output for opening or closing the air intake flap and receives an air intake flap open or closed position signal.

START P/B
• Discrete input signal to the ECB for starting sequences
•ECB discrete signal to the ON light during start sequence
•Discrete output signal to the AVAIL light when speed above 95% rpm
A discrete input signal from the START P/B initiates the starting sequences. The ECB sends a discrete signal to the ON light during the APU start sequence. A discrete output signal to the A/C energizes the AVAIL light in the START P/B when the APU speed is above 95% rpm.

BACK-UP AND MAIN START CONTACTORS
• Discrete input signal to the ECB
•discrete output signals to back up and main contactors
The ECB sends discrete output signals to the back-up and the main start contactors and receives as a feedback a discrete input from the main start contactor.

EMERGENCY STOP
• Discrete input signal from A/C for emergency shutdown logic
A discrete input signal from the A/C initiates the APU emergency shutdown logic after the ECB has received this signal.

LGCIU 1
• Flight/ground discrete input signal from LGCIU 1
The ECB receives the flight/ground discrete input signal from the Landing Gear Control and Interface Unit (LGCIU) 1.

APU FUEL FEED SYSTEM
• Discrete signal from APU low fuel pressure switch
•ECB sends discrete signal to the APU fuel LP SOV
The ECB receives a discrete signal from the APU low fuel pressure switch. It sends a discrete signal to the APU fuel LP Shut-Off Valve (SOV).

EIU
• MES signal from EIUs 1 or 2 to ECB
•IGVs fully open and bleed control valve in delivery position
During engine starts, the ECB receives a Main Engine Start (MES) signal from Engine Interface Units (EIUs) 1 or 2. This signal causes the ECB to position the Inlet Guide Vanes (IGVs) to the fully open position and the bleed control valve to modulate in delivery position.

BMC
• APU bleed P/B set to ON, BMCs 1 or 2 send a discrete input to the ECB
•Discrete output signal to the BMCs / BCV not in the closed position.
When the APU bleed P/B is set to ON, Bleed Monitoring Computers (BMCs) 1 or 2 send a discrete input to the ECB which controls the opening of the APU bleed control valve. ECB sends discrete output signal to the BMCs to indicate when the BCV is not in the closed position.

TSO/JAR
•Discrete input from the A/C signature PIN programming
•PIN programming to follow the TSO or the JAR
The ECB receives a discrete input from the A/C signature PIN programming. This open or ground signal determines whether the ECB follows the Technical Standard Order (TSO) or the Joint Aviation Requirements (JAR).

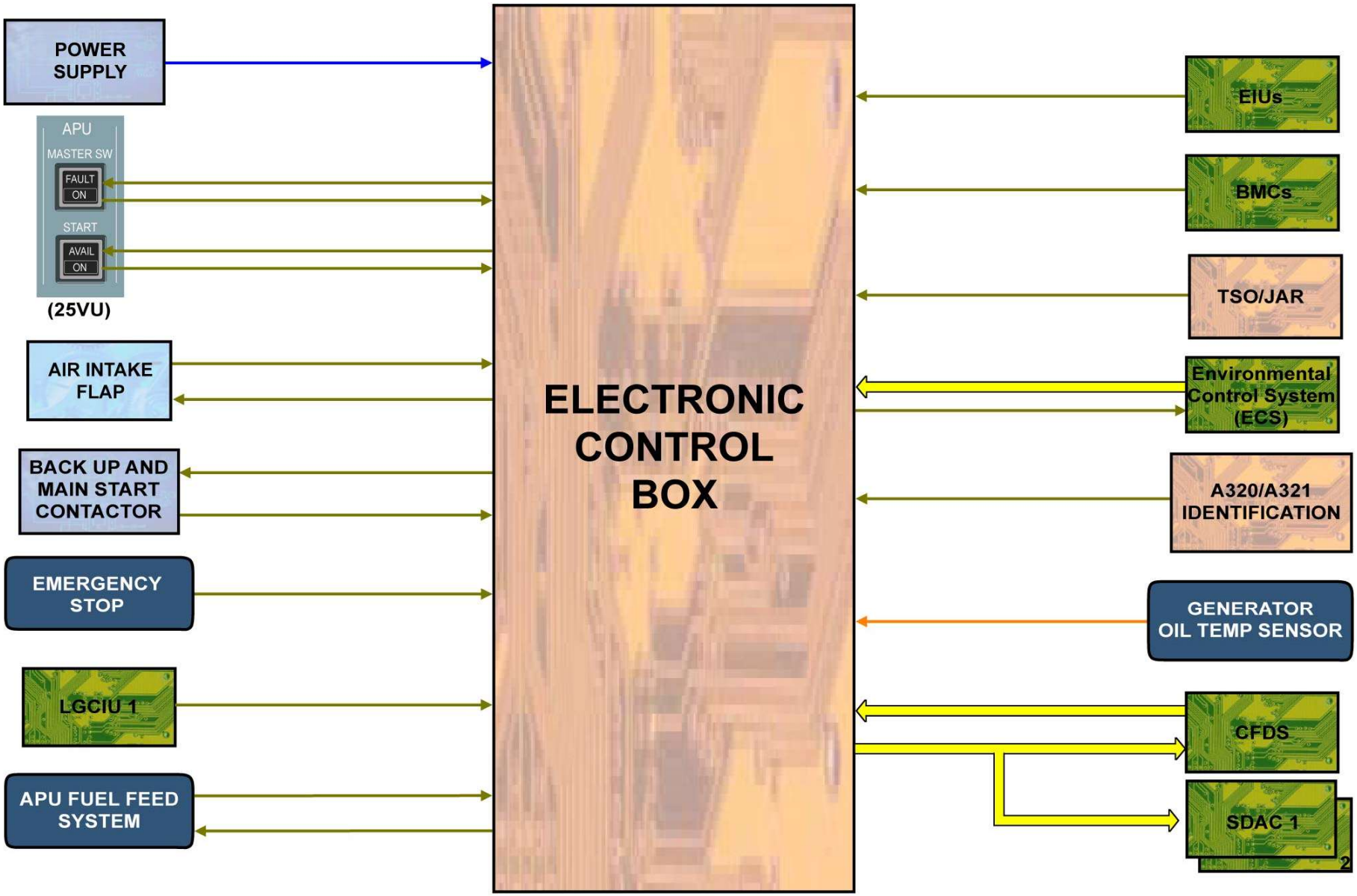
ENVIRONMENTAL CONTROL SYSTEM (ECS)
• ARINC 429 bus input from ACSC to control the IGVs
•Discrete output to the ACSC/bleed control valve in delivery position
The ECB receives, via an ARINC 429 bus, an input from the Air conditioning System Controller 1 and 2 (ACSC) to control the IGVs position according to the demand. The ECB sends a discrete output to the ACSC 1 and 2 to signal that the APU bleed valve is in delivery position.

A320/A321 IDENTIFICATION
• Discrete input from the A/C signature PIN programming
•Signal in order to allow the ECB to identify A321 or A320 specifications
The ECB receives a discrete input from the A/C signature PIN programming. This identification PIN lets the ECB identify the A321 applications for functional differences from those of an A320.

GENERATOR OIL TEMPERATURE SENSOR
• Analog input signal from the sensor
•Component mounted on the AC generator
The ECB receives an analog input from this sensor which is a component mounted on the AC generator.

SDAC
• ECB sends to SDACs 1 & 2 via ARINC 429 data buses
•Indications to the ECAM APU page and the ECAM EWD for shutdown warnings
The ECB sends to the System Data Acquisition Concentrators (SDACs) 1 and 2, via ARINC 429 data buses, the indications to show on the ECAM APU page and shutdown information to trigger the related warnings.

CFDS
• ECB is a BITE type 1 computer
•ECB connected to the CFDS via ARINC 429 data buses
The ECB is a BITE type 1 computer and is connected to the Centralized Fault Display System (CFDS) via ARINC 429 data buses.


POWER SUPPLY
APU
MASTER SW
FAULT
ON
START
AVAIL
ON
(25VU)
AIR INTAKE FLAP
BACK UP AND MAIN START CONTACTOR
EMERGENCY STOP
LGCIU 1
APU FUEL FEED SYSTEM
ELECTRONIC CONTROL BOX
EIUs
BMCs
TSO/JAR
Environmental Control System (ECS)
A320/A321 IDENTIFICATION
GENERATOR OIL TEMP SENSOR
CFDS
SDAC 1
2

Compartment Access Doors Opening And Closing

WARNING

•Do not touch the APU until it is sufficiently cool

•The three quick release fasteners on the left access door are correctly stowed

WARNING: DO NOT TOUCH THE AUXILIARY POWER UNIT (APU) UNTIL IT IS SUFFICIENTLY COOL TO PREVENT BURNS WHEN YOU DO THE MAINTENANCE TASK. MAKE SURE THAT THE THREE QUICK RELEASE FASTENERS ON THE APU LEFT ACCESS DOOR ARE CORRECTLY STOWED. THIS PREVENTS DAMAGE TO THE SEAL ON THE APU LEFT ACCESS DOOR.


WARNING
DO NOT TOUCH THE APU
UNTIL IT IS SUFFICIENTLY COOL
MAKE SURE THAT THE THREE QUICK
RELEASE FASTENERS ON THE APU LEFT
ACCESS DOOR ARE CORRECTLY STOWED

APU ACCESS DOORS OPENING PROCEDURE

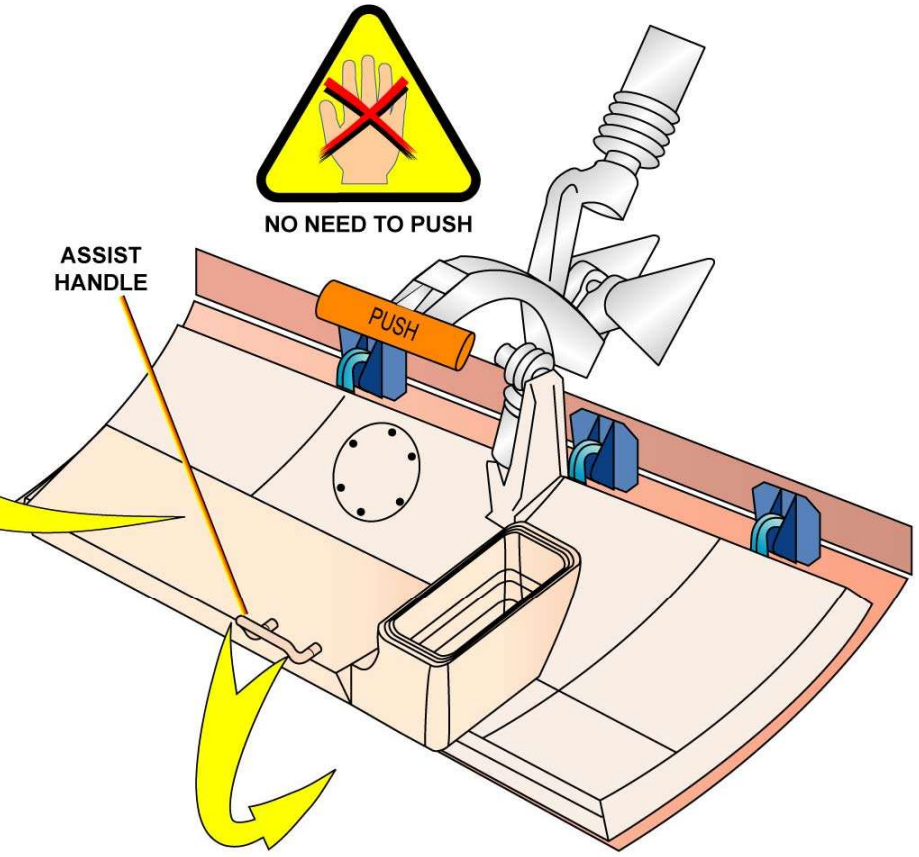
• Put warning notice on overhead panel 25 VU
•Open and tag the circuit breakers on panel 121 VU
•Start with the three latches
•release the two latches of the shoot bolts at the both ends of the LH access door.
•Release the LH access door
•Release the telescopic strut pip-pin and stretch the strut
•Push the LH access door further open and attach the telescopic strut
•Open the RH access door and release the two latches of the shoot bolts at both ends
•Push the handle outboard to move the RH access door in the over center position
•FILM: APU Access Door Opening Procedure

AMM Task 52-41-00-010-001

Before working on the APU, some precautions have to be taken in the Cockpit :
- on the Overhead Panel 25 VU, put a warning notice to tell people not to start the APU.
- on Panel 121 VU, open, safety and tag the Circuit Breakers.

To open the APU Access door, start with the three latches at the bottom of the door.
Push the snapper and pull the latch handle to open the three latches.
Hold the door and release the two latches of the shoot bolts at the both ends of the door.
Release the door and leave them in the vertical position.
Release the pip-pin and pull the end of the telescopic strut out until it locks.
Push the door further open and attach the telescopic strut with the pip-pin to the fuselage attach point.
Open the other APU access door and release the two latches of the shoot bolts at the end of the APU Access.
Take the handle to move the access door into the vertical position . After that push the handle outboard to move the access door in the over center position.

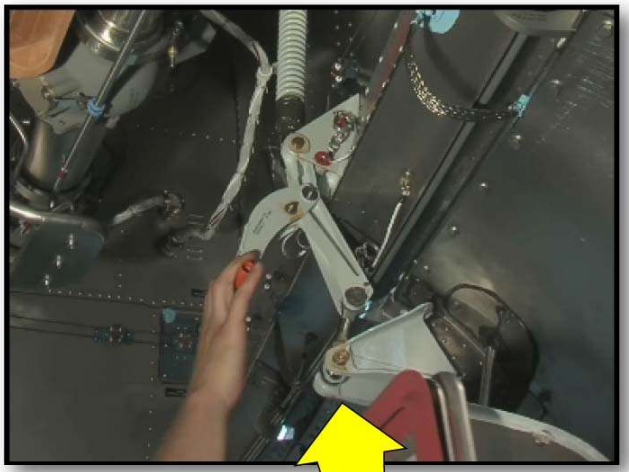

APU ACCESS DOORS OPENING PROCEDURE
FILM DURATION: 1 min 46 s

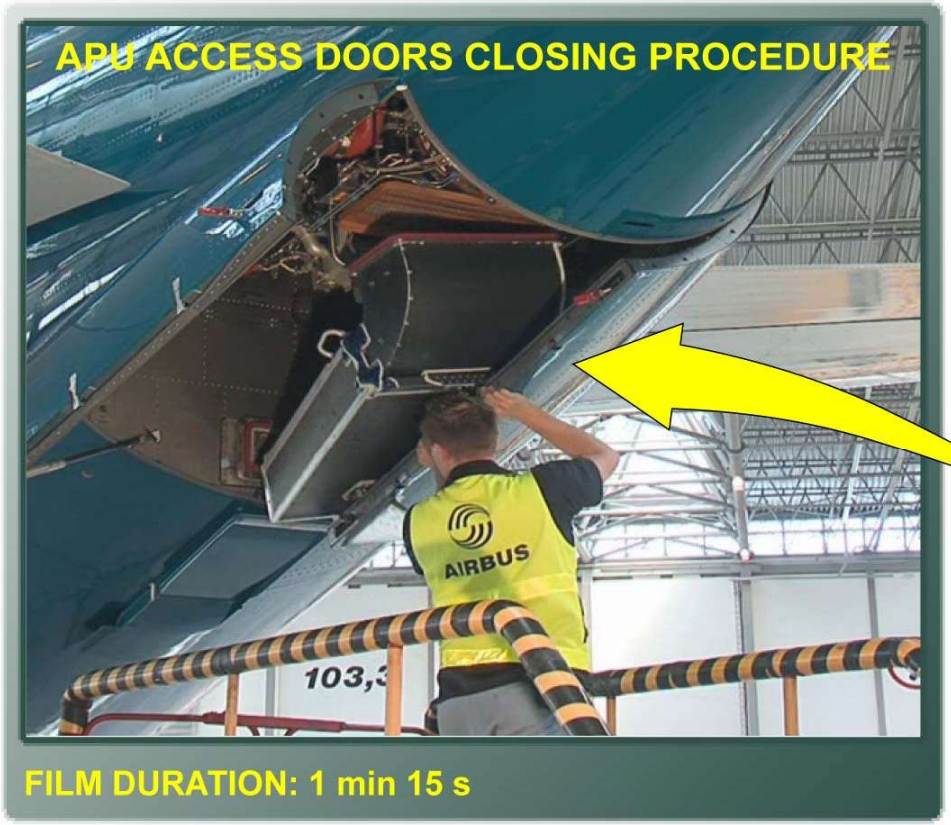

NO NEED TO PUSH
ASSIST HANDLE
PUSH

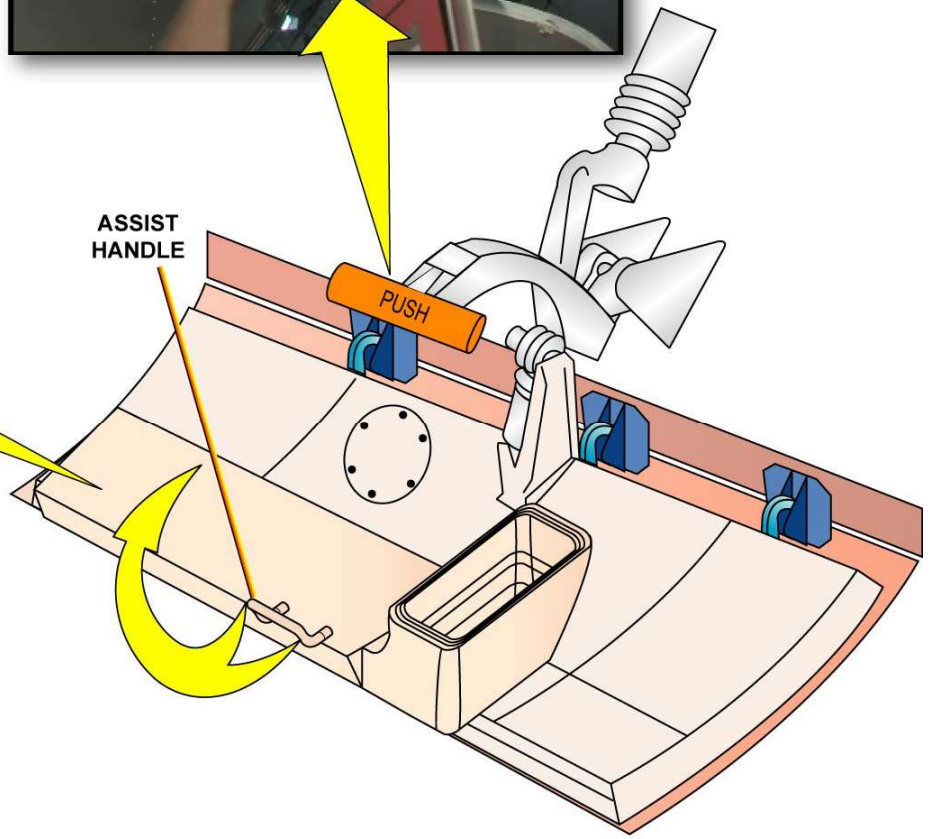
APU ACCESS DOORS CLOSING PROCEDURE

• Push the handle and the control handle outboard to release the RH access door from the over center position.
•Pull the handle to move the RH access door to the closed position and operate its two shoot-bolt latches.
•Hold the LH access door and release the telescopic strut pip-pin from the fuselage attach point.
•Stow the telescopic strut to the closed position and Lock it to the LH door attach point.
•Close the LH access door and lock it with its two shoot bolts.
•lock the LH access door remaining latches.
•Remove the Safety Precaution and the tags from the circuit breakers.
•FILM: APU Access Door Closing Procedure
AMM Task 52-41-00-410-001
Push the handle and the control handle outboard and release the access door from the over center position.
Pull the handle to move the access door to the closed position and operate the two shoot-bolt latches.
Hold the access door and release the pip-pin from the fuselage attach point.
Push the knurled grip back and move the telescopic strut to the closed position. Lock the telescopic strut to the door attach point.
Close the access door and lock it with the two shoot bolts.
At the bottom of the doors, lock the three latches.
Remove the Safety Precaution and the tags from the circuit breakers.

Press the handle to unlock the over centering point.



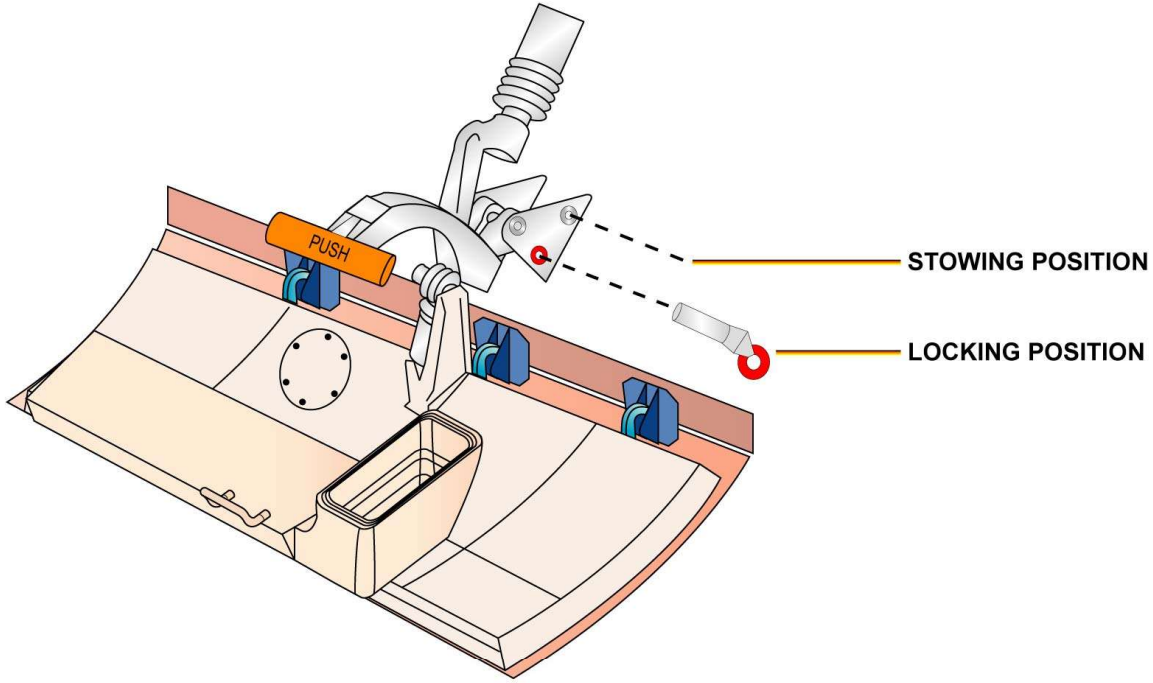




DOOR REMOVAL PRECAUTION

•Secure right access door hold-open by locking pin

CAUTION: In the event of door removal, you must secure the right access door hold-open device by inserting the locking pin in the locking hole. The pin is stowed next to this locking hole.



Auxiliary Power Unit System Line Maintenance

SERVICING
APU OIL SERVICING

• APU oil servicing is accomplished on an as-needed basis
•The only ECAM indication is the LOW OIL LEVEL advisory
    • 10 hours of APU operation

APU oil servicing is accomplished on an "as-needed" basis or after scheduled oil quantity checks. The oil indicating system shows if the oil quantity is sufficient or if an oil servicing is necessary.
The oil level information is displayed on the EIS and the Multipurpose Control & Display Units (MCDUs) in the cockpit on:
- the APU page on the lower ECAM display unit (LOW OIL LEVEL advisory),
- the APU SERVICE DATA page on the MCDU, indicating APU OIL Level O.K. or LOW.

Note: The advisory appears on the ECAM APU page when the oil level has reached the ADD mark on the APU oil tank.
Airbus recommends servicing the APU oil at the next daily maintenance when the LOW OIL LEVEL message comes on. With no oil leakage, sufficient oil is available to allow a further 10 hours of APU operation.

• Shut down APU
•Open APU cowl doors
•Select the operator-approved oil
•The oil may be serviced by the gravity or pressure fill procedure

Prior to servicing, shut down the APU and open the APU cowl doors. Make sure to use the operator approved oil for servicing (operators may select from the approved list). The oil may be serviced by the gravity (most common) or pressure fill procedure (optional).

• Gravity procedure
    • Open the lock and slowly loosen the oil filler cap to release remaining pressure from the oil reservoir
    • Check sight glass for level
    • Slowly add oil until the level is at the FULL mark on the sight glass

Gravity procedure:
- Open the lock and slowly loosen the oil filler cap to release remaining pressure from the oil reservoir,
- Check sight glass for level,
- Slowly add oil until the level is at the FULL mark on the sight glass.

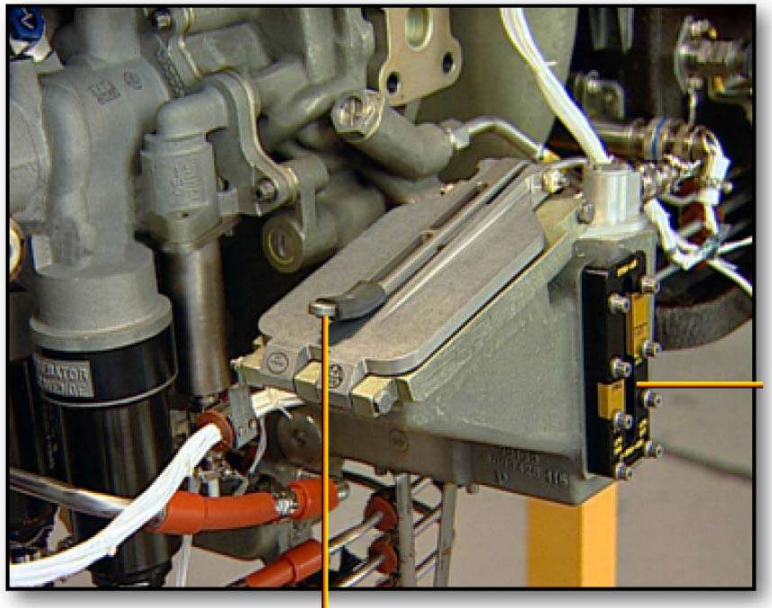
• Pressure fill procedure
    • Check sight glass for level
    • Connect pressure and overfill lines to APU gearbox
    • Slowly pump oil into the gearbox until the level is at the FULL mark on the sight glass

•Close and lock the filler cap

Pressure fill procedure:
- Check sight glass for level,
- Connect pressure and overfill lines to APU gearbox,
- Slowly pump oil into the gearbox until the level is at the FULL mark on the sight glass.

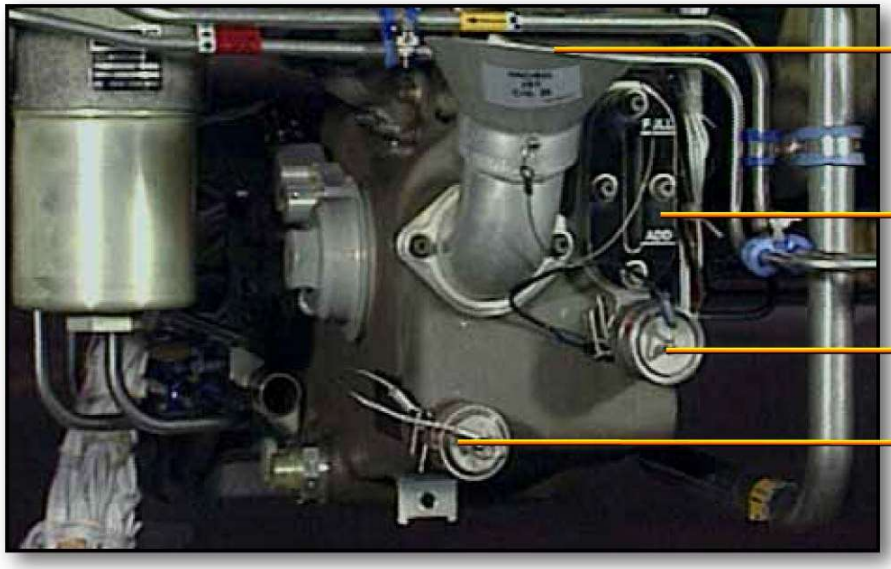
Close and lock the oil filler cap.

HONEYWELL 131-9A



AVOID FLUID SPILLAGE
USE APPROPRIATE STORAGE EQUIPMENT FOR CHEMICAL PRODUCTS

APS 3200



MEL/DEACTIVATION

• APU inlet may be deactivated OPEN or CLOSED

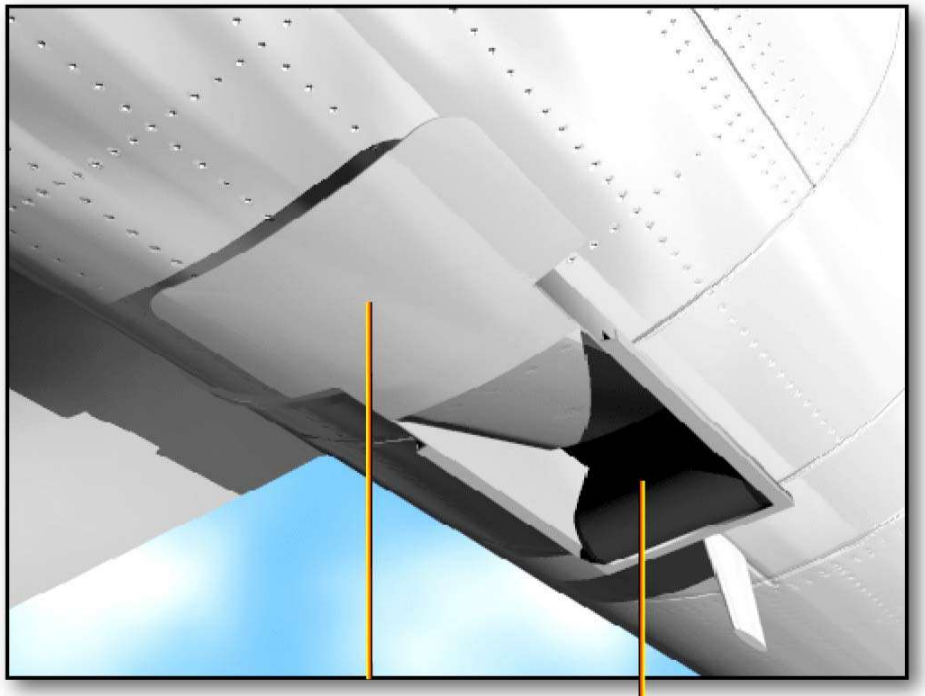
In case of an APU inlet actuator failure, the APU may be dispatched per MEL with the inlet OPEN or CLOSED. The APU will only be operational with the inlet deactivated OPEN (for a maximum of 10 days).

• The air inlet actuator has a manual drive

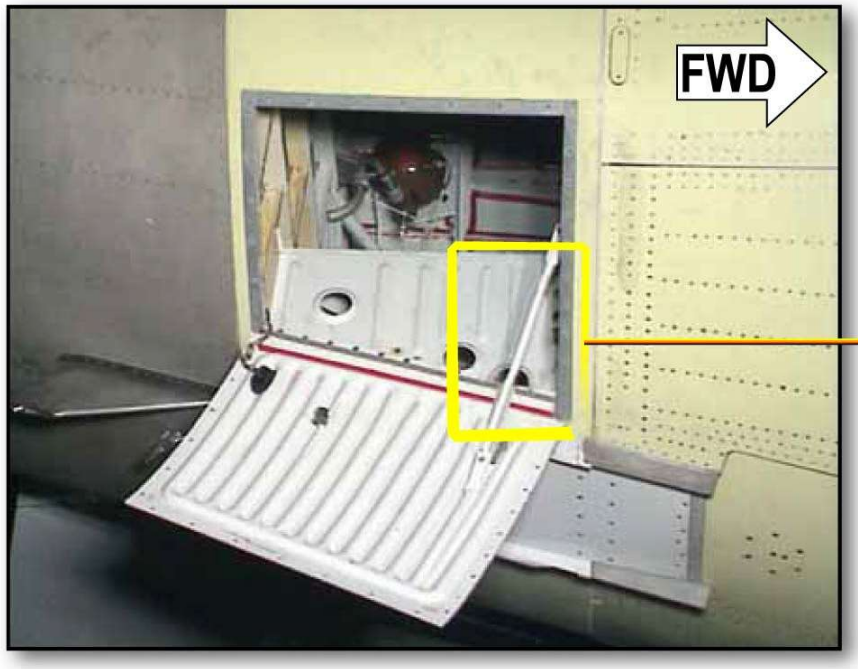
•Access door on RH fuselage near inlet

The air inlet actuator is equipped with a manual drive. In case of failure the manual drive may be used to move the inlet to the required position prior to deactivation. There are 2 different actuators that may be installed. One requires 47 turns of the manual drive for one full travel of the inlet. The other requires 87 turns. Access to the actuator is through an access door near the APU inlet on the right hand side of the fuselage.

✓ Deactivation of the air intake flap



AIR INTAKE ACCESS DOOR FUSELAGE R/H SIDE



•Get access to the actuator
•Disconnect the actuator electrical connector
- Install blanking cap

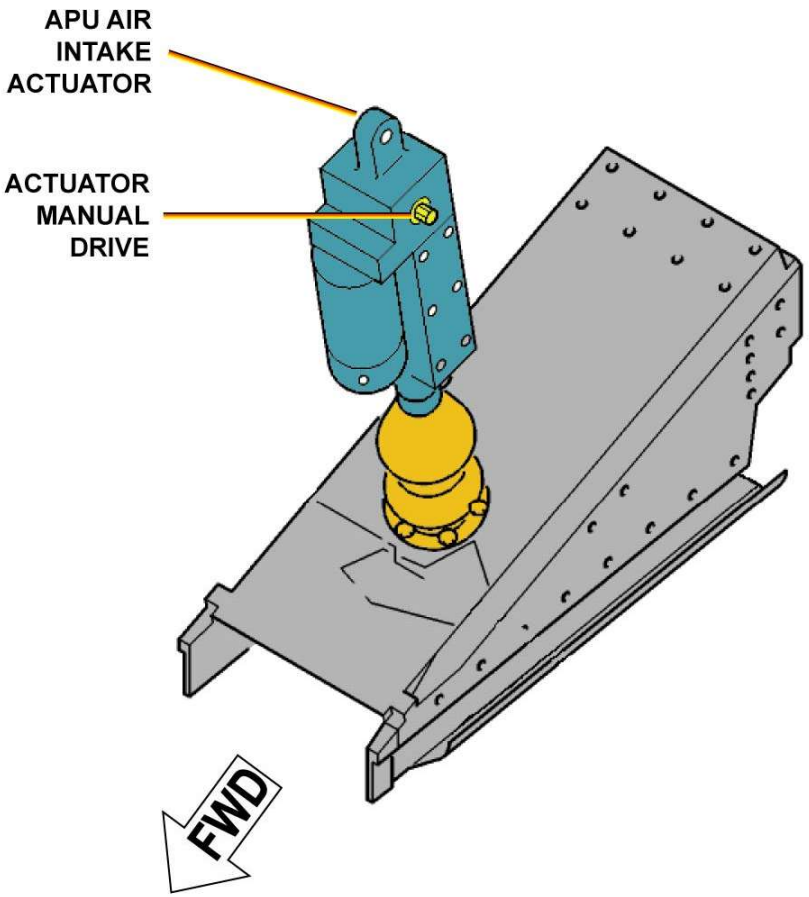
•Use manual drive to move the inlet
Deactivation procedure:
- get access to the actuator,
- disconnect the actuator electrical connector from the fixed connector on the frame and install a blanking cap,
- use the manual drive to move the inlet to the required position. Use a torque wrench to avoid damaging the actuator.

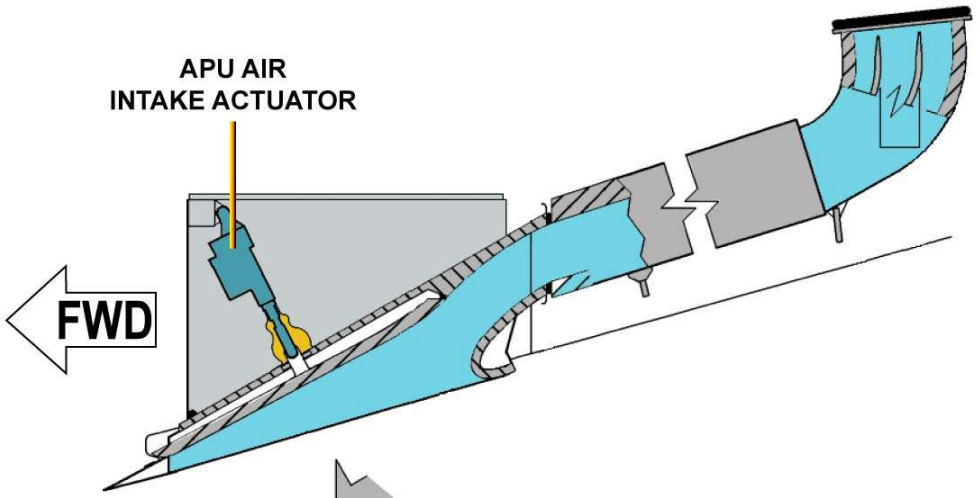
If the inlet is deactivated CLOSED, no further action is needed other than to placard the APU inoperative. If the inlet is deactivated OPEN, the following procedure has to be accomplished.

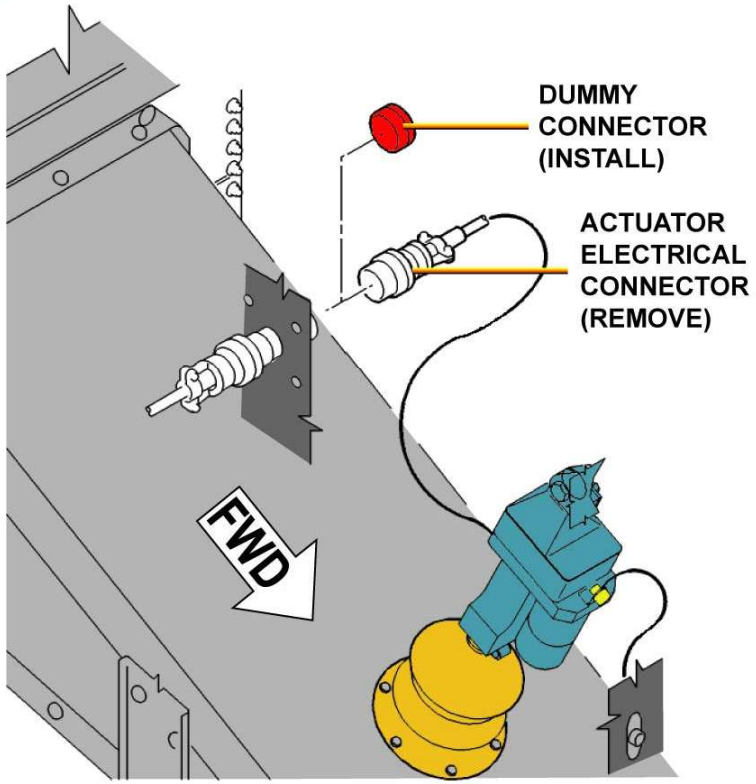
• When the inlet is in the OPEN position:
- Make a dummy connector (jumper lead) to close the circuit
- Paint the dummy connector red for easy identification

When the inlet is in the OPEN position, a jumper lead needs to be installed to close the circuit and allow the APU to start. Make a dummy connector and paint it red for easy identification.

✓ Deactivation of the air intake flap







MAINTENANCE TIPS

• Purge APU fuel line

- Drain valve on fuel supply line

The APU fuel supply line is equipped with a drain and vent valve which enables the line to be purged of air after maintenance. The drain valve is located in the APU compartment in the fuel supply line to the fuel control.

• Operate from APU compartment

- Use the FUEL VENT PUSH switch
- APU Master Switch off

A switch labeled FUEL VENT PUSH is installed on the APU compartment forward firewall to allow maintenance to operate the APU fuel pump and purge the fuel line from the APU compartment. This switch allows the APU pump to operate and the APU Low Pressure fuel valve to open without the APU Master Switch ON.

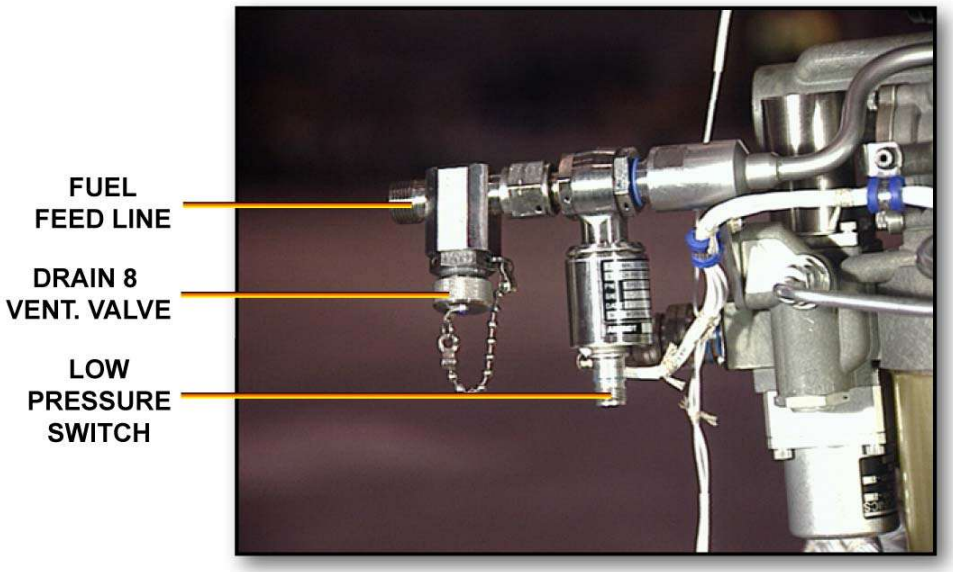
• Use the Drain valve adapter tool

•Push and hold FUEL VENT switch to supply fuel

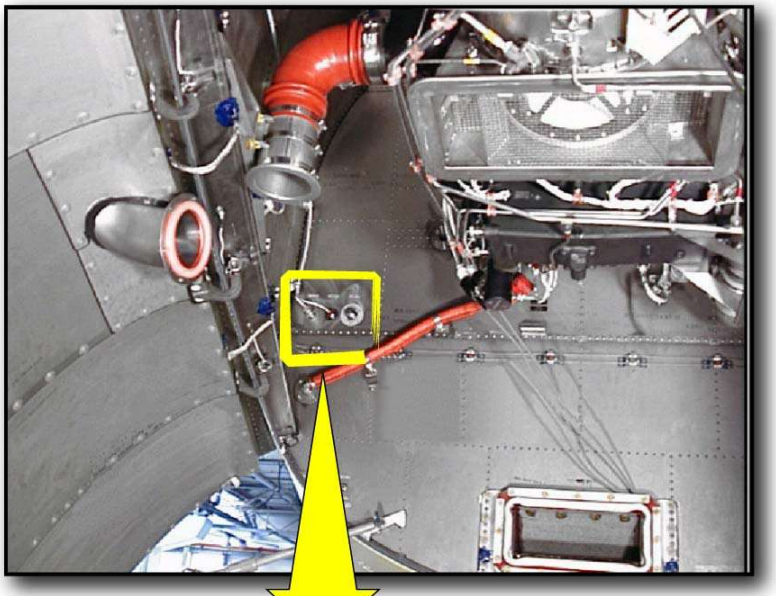
A drain valve adapter tool is connected to the drain valve.

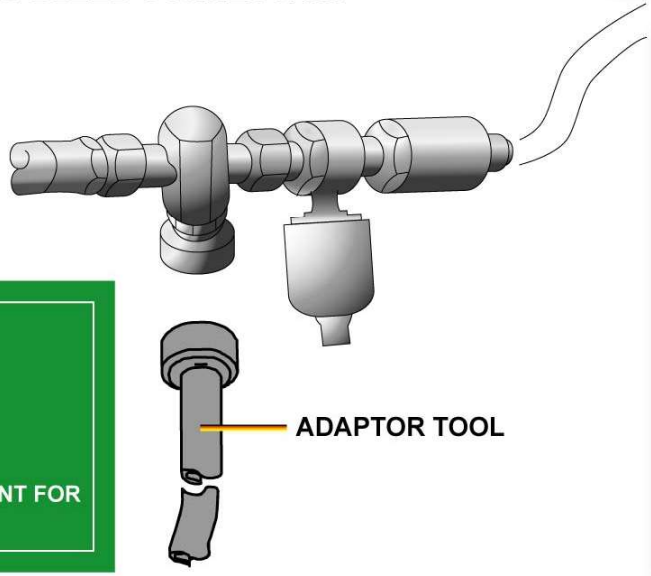
On the front firewall of the APU compartment:

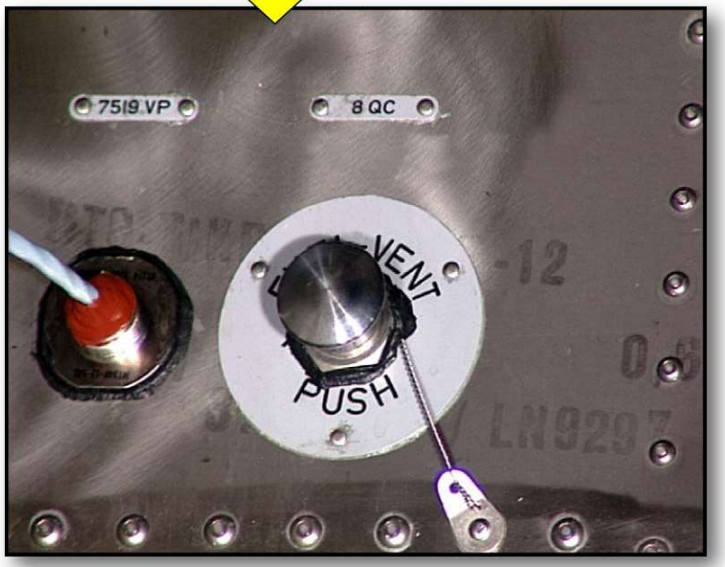
- Push and hold the FUEL VENT pushbutton switch. At the APU fuel vent and drain valve, a continuous flow of fuel indicates that the APU fuel pump is operating and the line is purged,
- Release the FUEL VENT pushbutton switch. The flow of fuel stops when the APU fuel pump stops running,
- Disconnect the adapter tool.



APU BLEED CONNECTION





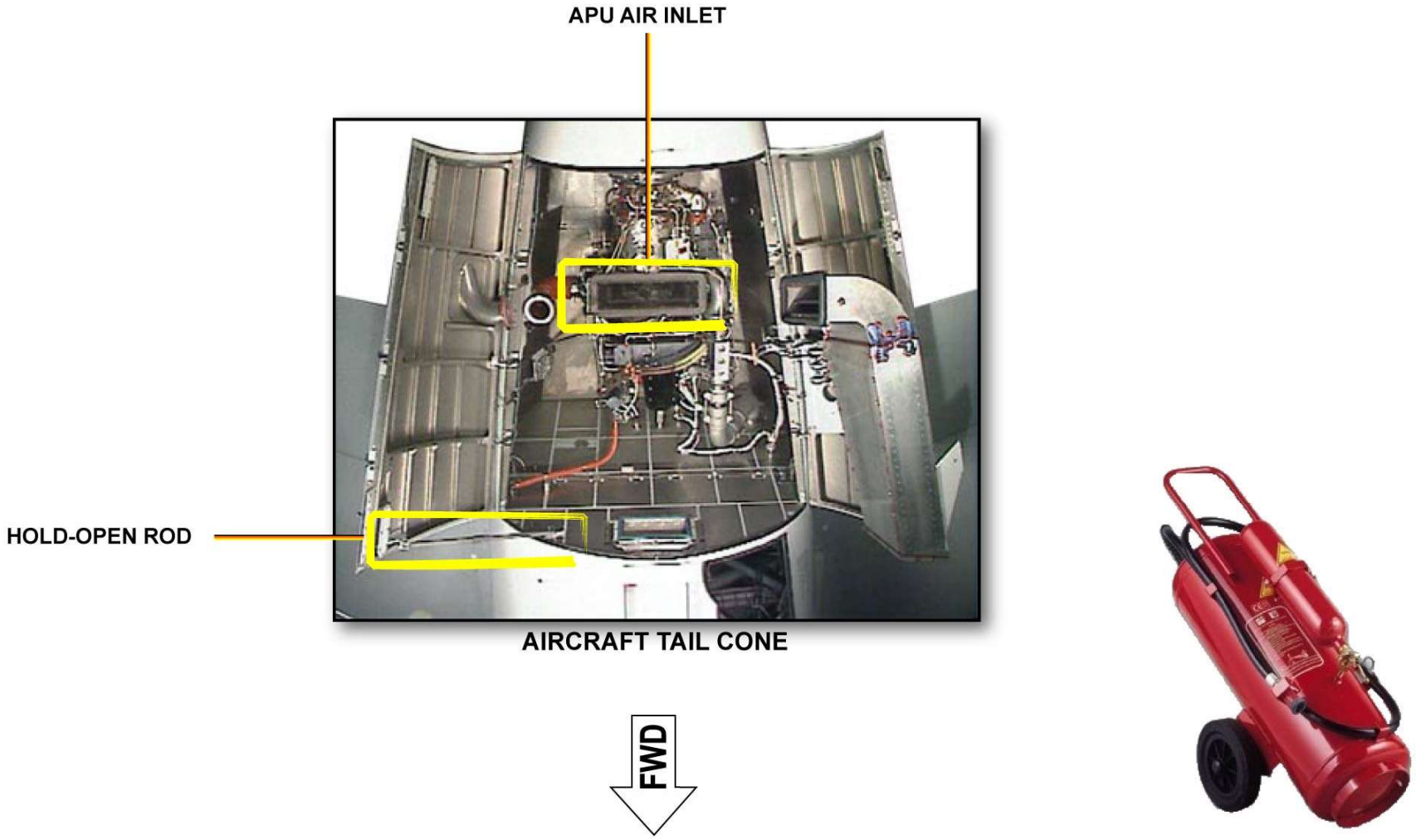


APU FUEL LINE P/B

AVOID FLUID SPILLAGE
USE APPROPRIATE STORAGE EQUIPMENT FOR CHEMICAL PRODUCTS

APU OPERATION WITH COWL DOORS OPEN

Make sure the doors are secured in the Open position
Be aware of suction at inlet
Make sure proper fire-fighting equipment is available
If it is necessary to operate the APU for maintenance with the cowls open, be sure to:
- Make sure the doors are secured in the Open position,
- Be aware of suction at inlet. Small items could be ingested,
- Make sure that proper fire-fighting equipment is available.


APU AIR INLET
HOLD-OPEN ROD
AIRCRAFT TAIL CONE
FWD

END