70.00 CONTENTS

70.90 CONTROLS AND INDICATORS

70.98 ELECTRICAL SUPPLY

GENERAL

R The CFM 56-5B engine is a high bypass ratio turbofan.

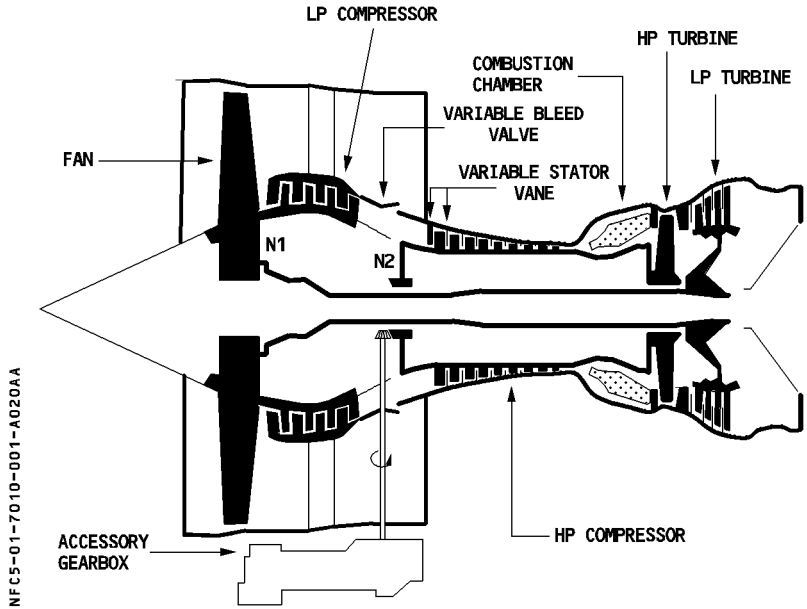
DESCRIPTION

– **Low-pressure (LP) compressor/turbine**
The low-speed rotor (N1) consists of a front fan (single-stage) and a four-stage LP compressor connected to a four-stage LP turbine.

– **High-pressure (HP) compressor/turbine**
The high-speed rotor (N2) consists of a nine-stage HP compressor connected to a single-stage HP turbine.

– **Combustion chamber**
The annular combustion chamber is fitted with 20 fuel nozzles and 2 igniters.

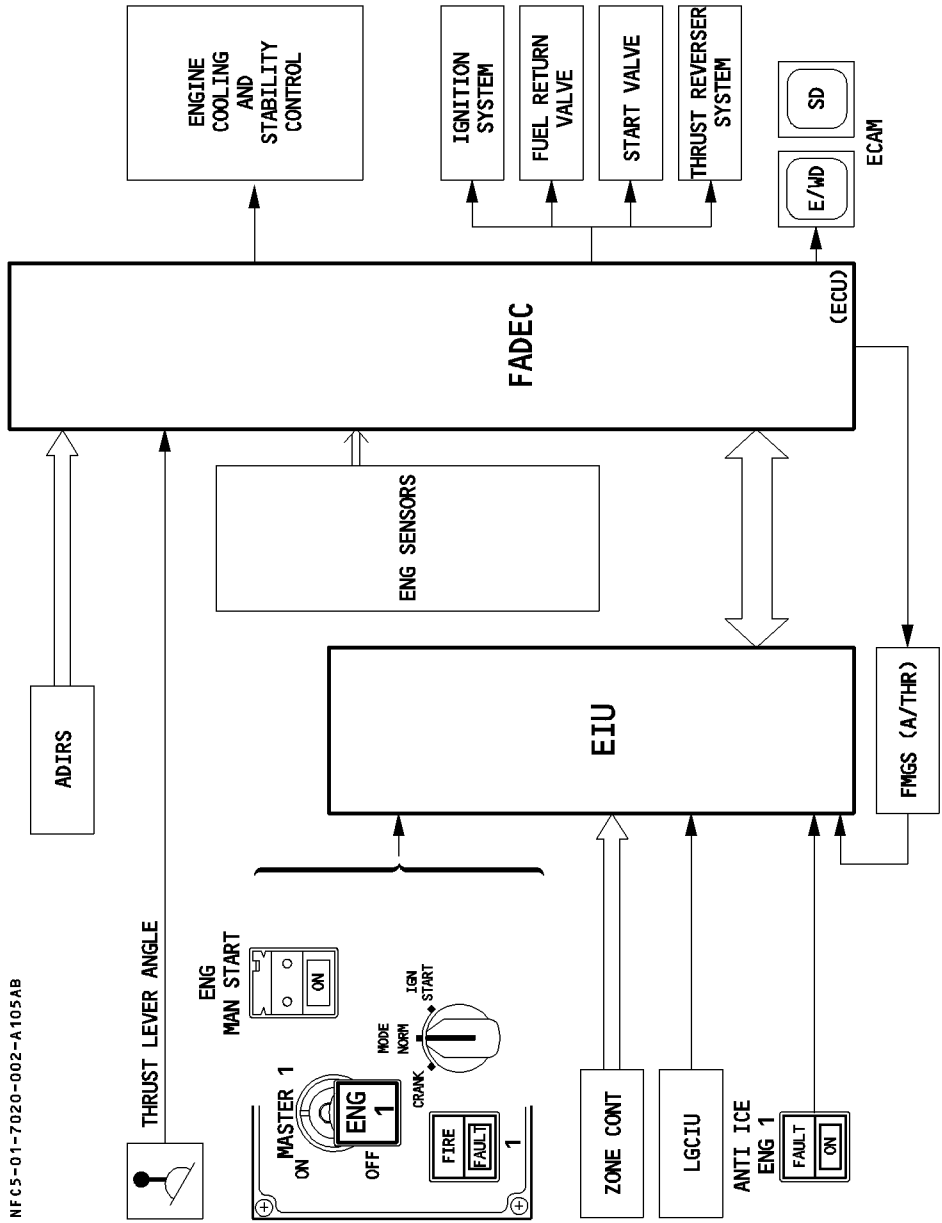
– **Accessory gearbox**
The accessory gearbox, located at the bottom of the fan case, receives torque from horizontal HP rotor drive shaft and drives gearbox mounted accessories.



GENERAL

Each powerplant has a FADEC (Full Authority Digital Engine Control) system.
FADEC, also called the Electronic Control Unit (ECU), is a digital control system that performs complete engine management.
FADEC has two-channel redundancy, with one channel active and one in standby.
If one channel fails, the other automatically takes control.
The system has a magnetic alternator for an internal power source.
FADEC is mounted on the fan case.
The Engine Interface Unit (EIU) transmits to FADEC the data it uses for engine management.

R


ENGINE COOLING AND STABILITY CONTROL
IGNITION SYSTEM
FUEL RETURN VALVE
START VALVE
THRUST REVERSER SYSTEM
SD
E/WD
ECAM
FADEC
(ECU)
ENG SENSORS
ADIRS
EIU
FMGS (A/THR)
THRUST LEVER ANGLE
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ON
MODE
NORM
IGN START
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MASTER 1
ON
OFF
ENG 1
FIRE
FAULT
1
ZONE CONT
LGCIU
ANTI ICE ENG 1
FAULT
ON
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FUNCTIONS

The FADEC system performs the following functions :

Control of gas generator
- control of fuel flow
- acceleration and deceleration schedules
- variable bleed valve and variable stator vane schedules
- control of turbine clearance
- idle setting

Protection against engine exceeding limits
- protection against N1 and N2 overspeed
- monitoring of EGT during engine start

Power management
- automatic control of engine thrust rating
- computation of thrust parameter limits
- manual management of power as a function of thrust lever position
- automatic management of power (A/THR demand).

Automatic engine starting sequence
- control of :
  - the start valve (ON/OFF)
  - the HP fuel valve
  - the fuel flow
  - the ignition (ON/OFF)
- monitoring of N1, N2, FF and EGT
- initiation of abort and recycle (on the ground only)

Manual engine starting sequence
- passive monitoring of engine
- control of :
  - the start valve
  - the HP fuel valve
  - the ignition

Thrust reverser control

· actuation of the blocker doors
· engine setting during reverser operation

Fuel recirculation control

· recirculation of fuel to the fuel tanks according to the engine oil temperature, the fuel system configuration and the flight phase.

Transmission of engine parameters and engine monitoring information to cockpit indicators

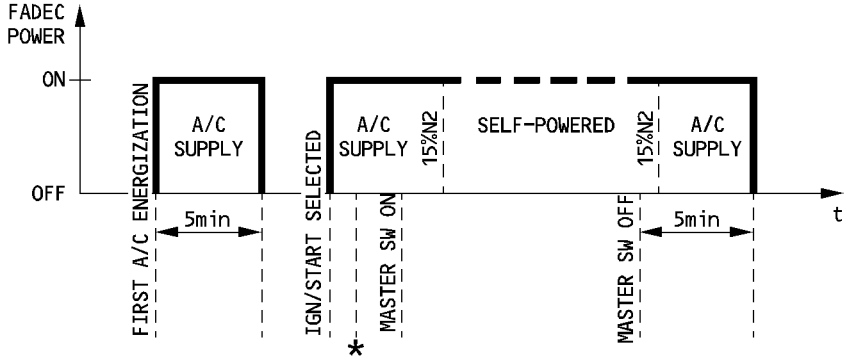
· the primary engine parameters
· the starting system status
· the thrust reverser system status
· the FADEC system status

Detection, isolation, and recording of failures

FADEC cooling

POWER SUPPLY

R The FADEC system is self-powered above 15 % N2.
R

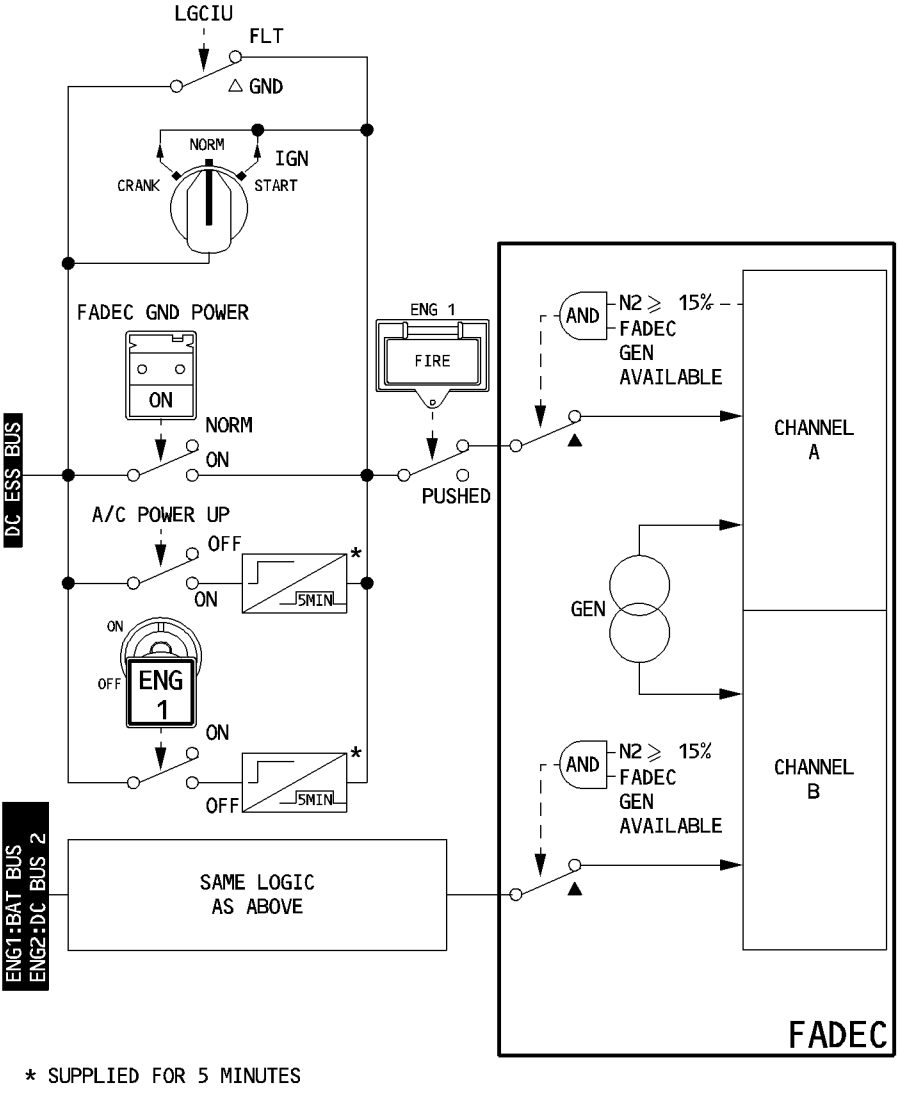


*: if ENG MODE selector is set to NORM position before engine start,FADEC supply is cut off

FADEC POWER SUPPLY

FOR INFO

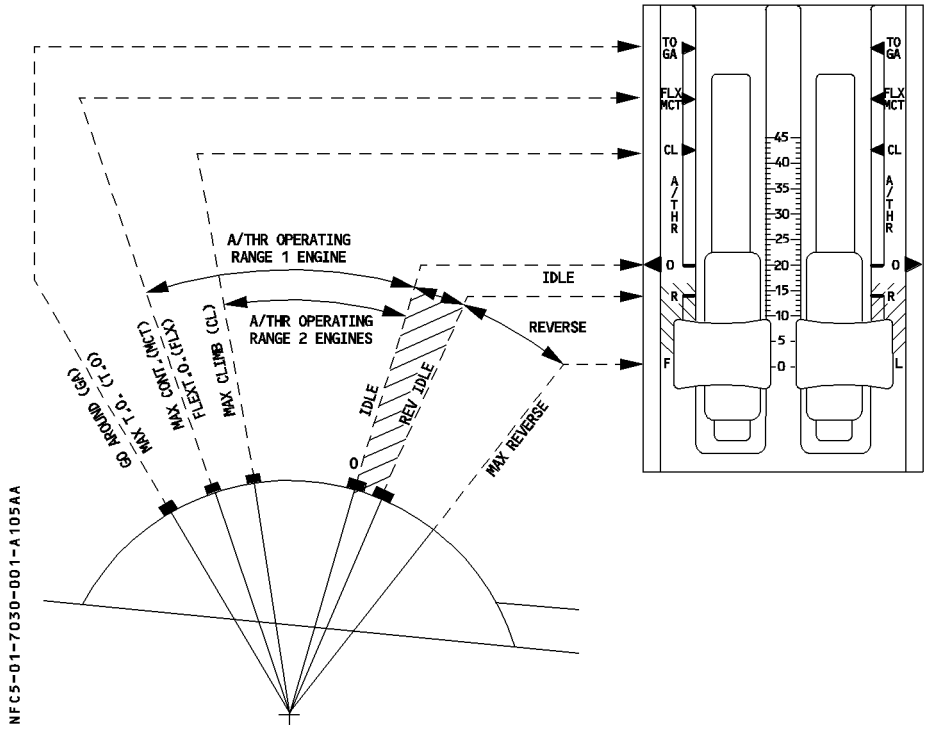
R



GENERAL

A FADEC dedicated to each engine controls thrust.
The pilot uses the thrust levers to set the thrust in manual mode, and the FMGS sets the thrust in automatic mode.
The FADEC prevents the thrust from exceeding the limit for the thrust lever position in both manual and automatic modes.

THRUST LEVERS



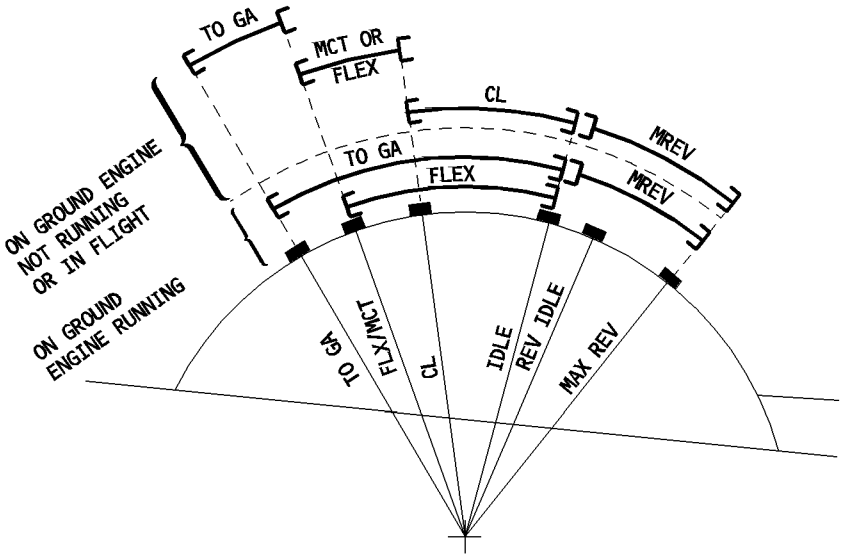
The thrust levers can only be moved manually.
They move over a sector that is divided into four operating segments.
The sector has five positions defined by detents or stops.
Thrust lever position is transmitted to the FADEC, which computes and displays the thrust rating limit and the N1 for that Thrust Lever Angle (TLA).

Note : There is no reverse idle detent. When the pilot moves the lever out of the idle stop by pulling up the reverse lever on the front of the thrust lever, he selects reverse idle.

THRUST RATING LIMIT

The FADEC computes the thrust rating limit for each thrust lever position, as shown below.
If the thrust lever is set in a detent, the FADEC selects the rating limit corresponding to this detent.
If the thrust lever is set between two detents, the FADEC selects the rating limit corresponding to the higher detent.

RATING LIMITS :



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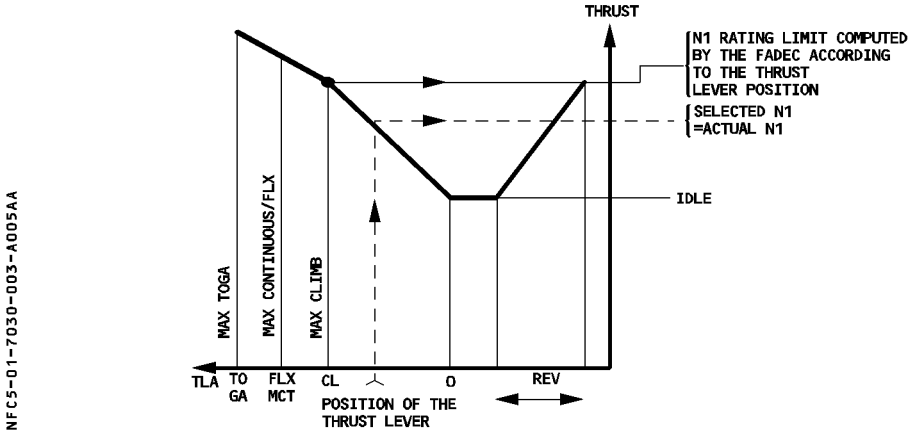
THRUST CONTROL

MANUAL MODE

The engines are in the manual mode provided the A/THR function is :
– not armed or
– armed and not active (thrust lever not in the A/THR operating range and no alpha floor).
In these conditions, each engine is controlled by the position of its thrust lever.
The pilot controls thrust by moving the thrust lever between the IDLE and TOGA positions.
Each position of the thrust lever within these limits corresponds to an N1.
When the thrust lever is in a detent, the corresponding N1 is equal to the N1 rating limit computed by the FADEC for that engine.



When the thrust lever is in the FLX/MCT detent :

– **On the ground**
The engine runs at the flex takeoff thrust rating if the crew has selected a flex takeoff temperature on the MCDU that is higher than the current Total Air Temperature (TAT). Otherwise the engine produces Maximum Continuous Thrust (MCT).

Note : A change in FLEX TEMP during the takeoff has no effect on the thrust.

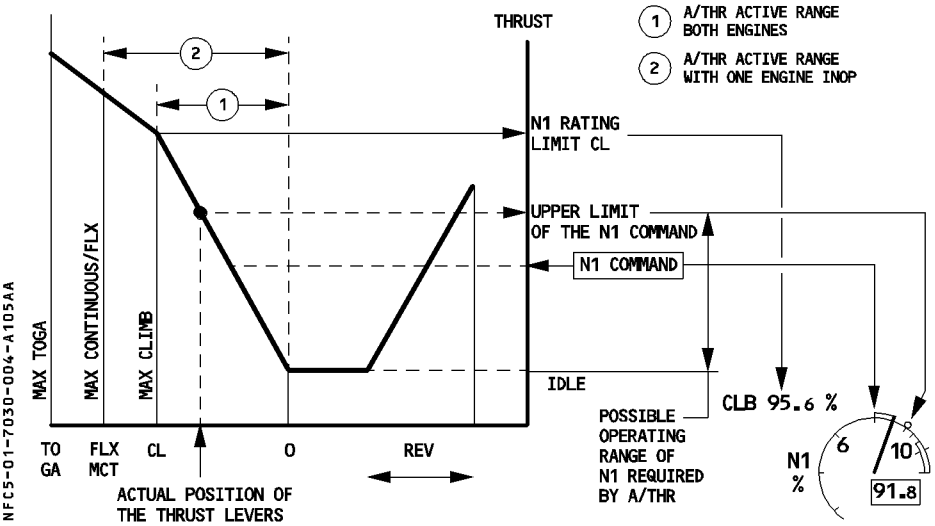
– **After takeoff**
The pilot can change from FLX to MCT by moving the thrust lever to TOGA or CL, then back to MCT. After that, he cannot use the FLX rating.

R *Note : Setting the thrust lever out of FLX/MCT detent without reaching TOGA or CL*
R *detent has no effect.*

The pilot can always get MAX TO thrust by pushing the thrust lever all the way forward.

AUTOMATIC MODE

In the autothrust mode (A/THR function active), the FMGC computes the thrust which is limited to the value corresponding to the thrust lever position (unless the alpha-floor mode is activated).



INDICATIONS ON FMA

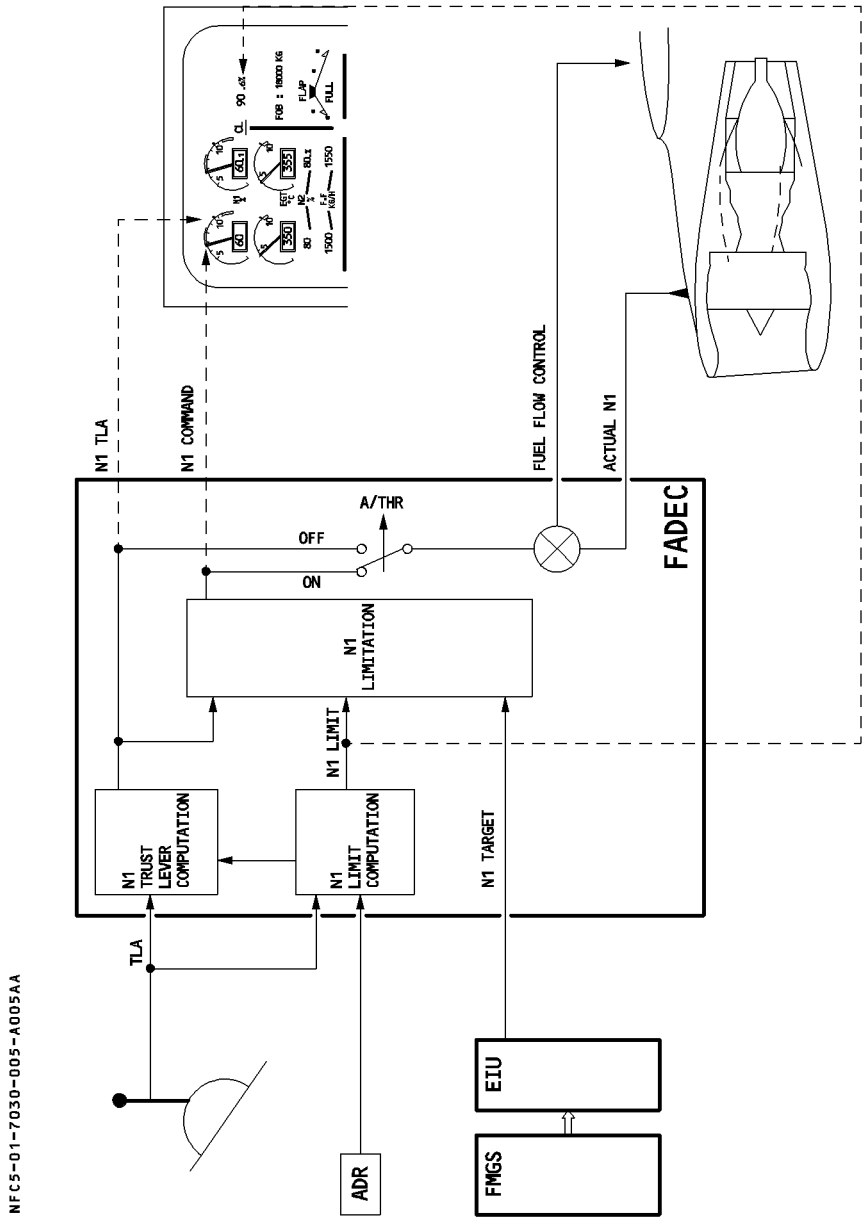
The FADECs monitor the positions of the thrust levers, and trigger appropriate indications on the FMA.

LVR ASYM : appears in amber (3rd line on the FMA) if, with A/THR active and both engines running, one thrust lever is set out of the CLB detent.

LVR CLB : flashes white (3rd line on the FMA) if the thrust levers are not in CL position while the aircraft is above the altitude of thrust reduction with both engines running.

LVR MCT : flashes white (3rd line on the FMA) if the thrust levers are not in MCT position after an engine failure (with speed above green dot).

THRUST CONTROL



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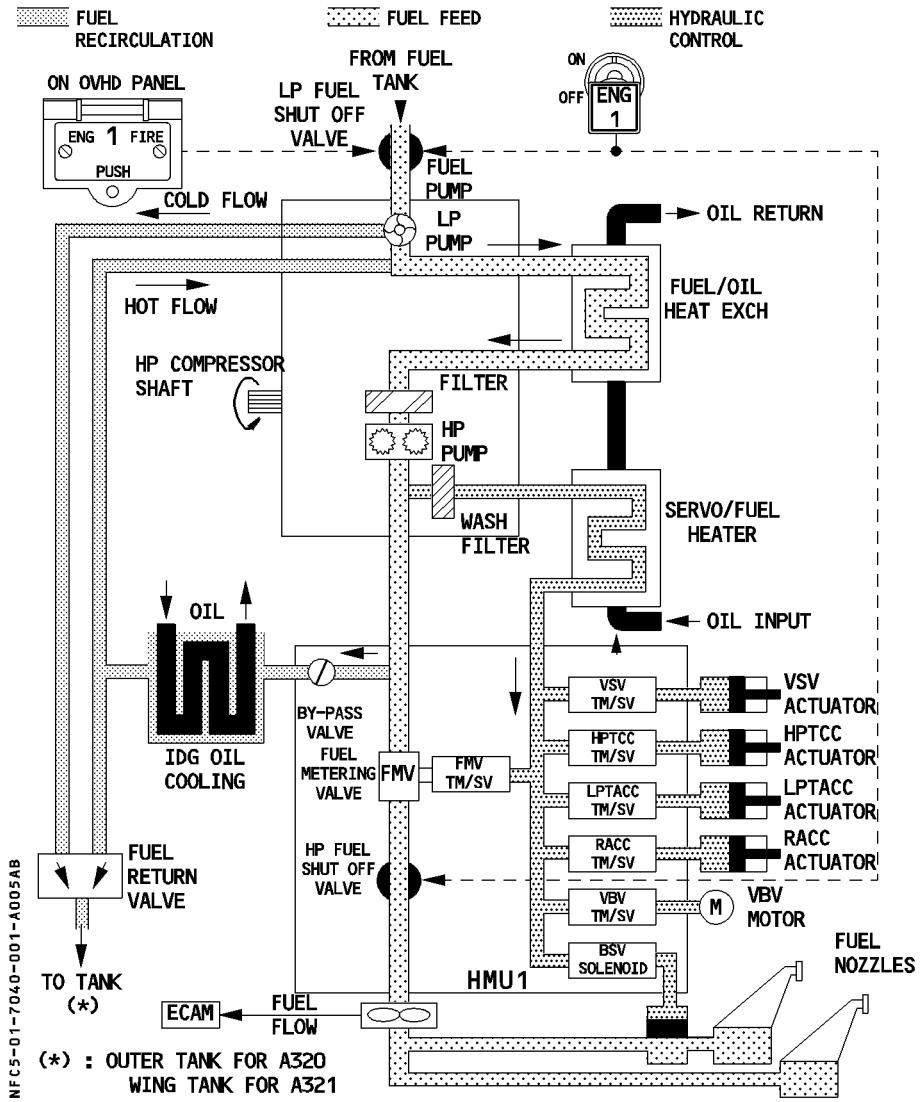
GENERAL

The fuel system supplies fuel to the combustion chamber at the required flow rate, pressure, and temperature.
The fuel flows from the tank, via the fuel pump unit and the fuel/oil heat exchanger, to the Hydromechanical Unit (HMU) and to the fuel nozzles.

FOR INFO



FUEL PUMP UNIT

The HP compressor shaft drives the HP fuel pump assembly. Fuel flows through the LP pump, then through the fuel/oil heat exchanger and the HP pump (gear pump).
The fuel then divides into a filtered flow for the servo fuel heater and the servo valves of the HMU, and an unfiltered flow for the metering valve of the HMU.

SHUT-OFF VALVES

Moving the ENG1 (ENG2) MASTER switch to OFF directly commands the closing of the LP and HP fuel shut off valves for that engine's fuel system.
It also closes the fuel return valve and opens the bypass valve.

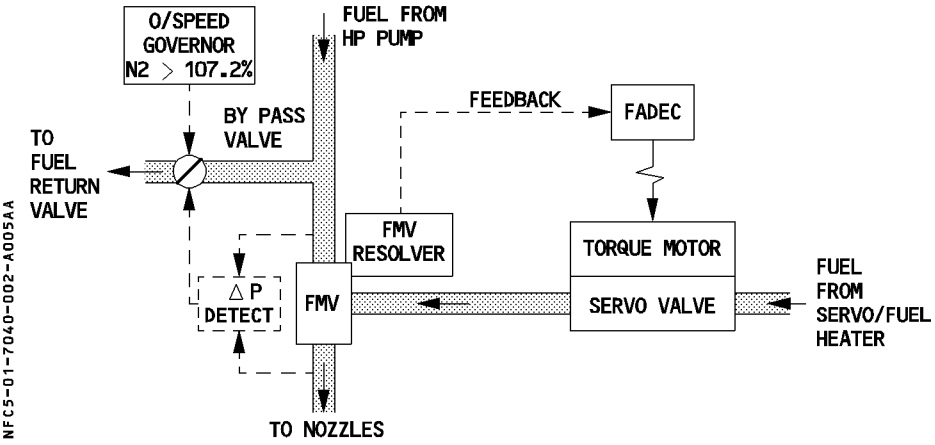
HYDROMECHANICAL UNIT

The FADEC controls the HMU, which :
- controls fuel flow to the engine combustion chamber
- controls fuel hydraulic signals to actuators
- protects against overspeeding.

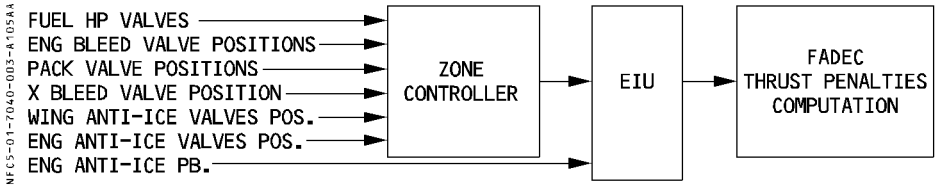
FUEL FLOW

FOR INFO

The Fuel Metering Valve (FMV) transforms FADEC orders through a torque motor and servo valve into fuel flow to the engine fuel nozzles.
The FMV resolver generates a feedback signal proportional to the FMV position.
The bypass valve maintains a constant pressure drop across the FMV to ensure that the metered fuel flow is proportional to the FMV position.



The FADEC computes the fuel flow that will maintain the target N1.
As the FADEC maintains this N1, it allows N2 to vary while remaining between N2 minimum and N2 maximum. The FADEC also controls the engine parameters to :
– Limit acceleration and deceleration ;
– Avoid engine stall or flameout ;
– Limit maximum N1 and N2 ;
– Maintain air bleed pressure requirement.
The FADEC computes an N2 correction according to the bleed configuration.



OVERSPEED GOVERNOR SYSTEM

Independent of the FADEC, the overspeed governor limits the N2 by opening the fuel bypass valve, in the event of a malfunction that could lead to an overspeed condition.

IDLE CONTROL

The FADEC has the following three idle modes :

Modulated idle

R – Is regulated according to :
  · bleed system demand
– Is selected :
  · In flight, when the flaps are retracted (FLAPS lever at zero position),
  · On ground, provided reverse is not selected.

Approach idle :

R – Is regulated according to aircraft altitude, regardless of bleed system demand.
– Is selected in flight, when the flaps are extended (FLAPS lever not at zero position)
– Allows the engine to accelerate rapidly from idle to go-around thrust

Reverse idle :

Is selected on ground, when the thrust lever is in REV IDLE position.
Is slightly higher than forward idle thrust.

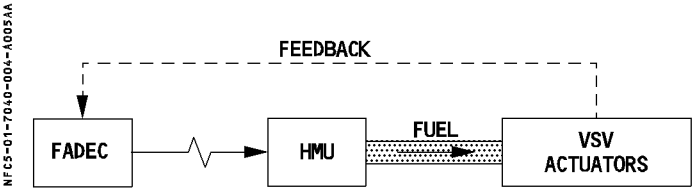
FUEL HYDRAULIC SIGNALS

FOR INFO

Fuel hydraulic signals go to :

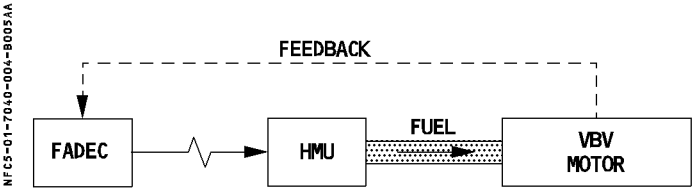
- *Low Pressure Turbine Clearance Control (LPTCC) valves (Refer to 1.70.60)*
- *High Pressure Turbine Clearance Control (HPTCC) valves (Refer to 1.70.60)*
- *Rotor Active Clearance Control (RACC) system (Refer to 1.70.60)*
- *Variable Stator Vanes (VSV)*

  The VSV system positions the compressor variable vanes.
  The FADEC maintains optimum compressor efficiency at a steady state and an adequate stall margin for transient engine operation.
  VSVs are fully closed during engine start and are fully open at high thrust.



- *Variable Bleed Valves (VBV)*

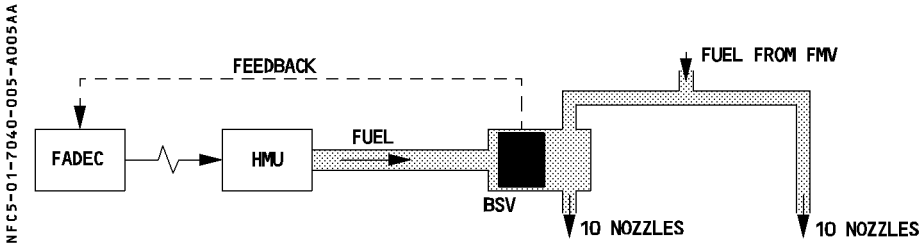
  The FADEC controls the VBVs, upstream of the HP compressor. Their setting depends on compressor inlet temperature and on N2. It varies between full open (start, low thrust, and during fast deceleration) and full closed (high thrust) positions.



FOR INFO

– *Burner Staging Valve (BSV)*
The FADEC controls the BSV, which allows fuel to go to either 10 or 20 fuel nozzles :
- *It supplies 10 nozzles permanently.*
- *It supplies the other 10 nozzles when the engine requires a high fuel-air ratio (BSV open).*

The BSV is closed during engine deceleration and low idle.
If the fuel control system fails, an internal safety system ensures that all nozzles are supplied.



IDG COOLING SYSTEM

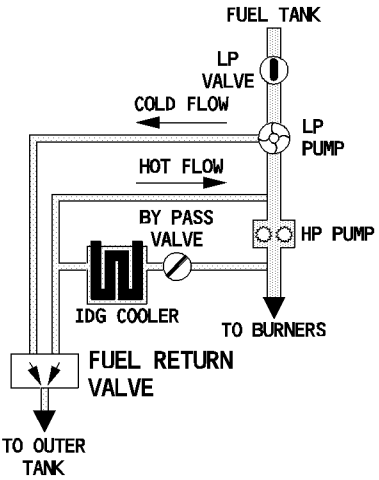
Some of the fuel flowing out of the HMU goes to cool the oil systems of the Integrated Drive Generators (IDGs). It then returns to the fuel pump unit or to the tank.
The Fuel Return Valve (FRV), controlled by the FADEC, ensures that this flow is adequate.

FOR INFO

At low engine thrust, if the oil going into the IDG is too hot, the cooling fuel is sent back to the tank (300 kg/h).
If oil temperature continues to rise, the ECU increases the minimum N2.
If oil temperature still keeps rising, the FADEC increases the fuel flow to the tank (from 300 to 600 kg/h, depending on fuel return temperature).
The fuel return valve is always mixing hot fuel with cold fuel so that the temperature of fuel returning to the tank stays below 100°C (from 200 to 400 kg/h, depending on fuel return temperature).
Fuel recirculation to the tank is inhibited (FVR closed) in the following cases :

- *at engine shutdown*
- *during takeoff and climb*
- *if :*
  - *wing tank level is below about 300 kg (660 lb).*
  - *there is fuel overflow in the surge tank*
  - *fuel feed is by gravity only.*
- *when fuel temperature in the wing tank in flight is above 52.5°C*

Note : On the ground high fuel temperature in the wing tanks does not cause the FRV to close.



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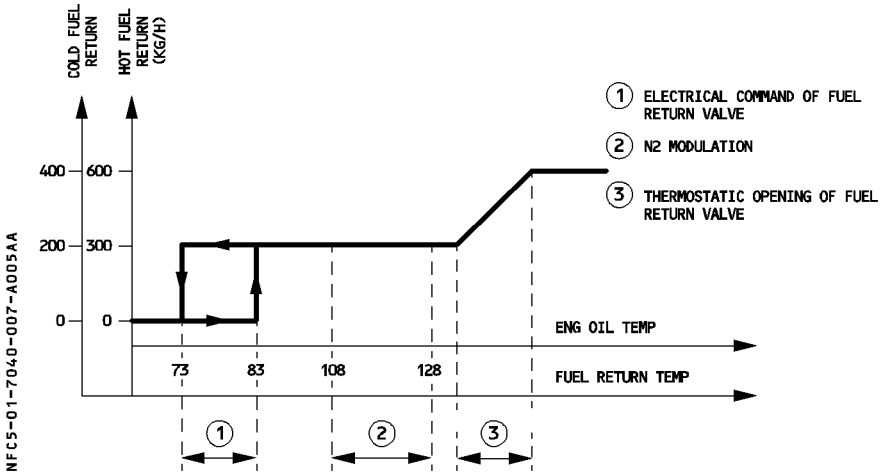
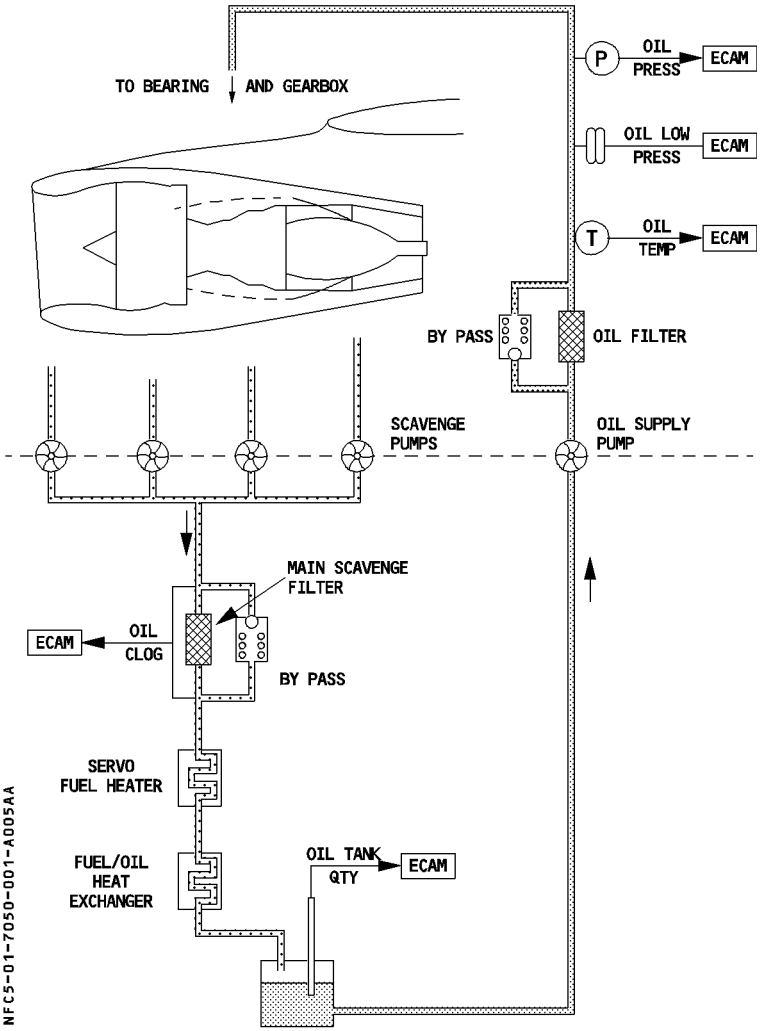

COLD FUEL RETURN
HOT FUEL RETURN (KG/H)
400
600
200
300
0
0
73
83
108
128
ENG OIL TEMP
FUEL RETURN TEMP
1
2
3
1 ELECTRICAL COMMAND OF FUEL RETURN VALVE
2 N2 MODULATION
3 THERMOSTATIC OPENING OF FUEL RETURN VALVE
NFC5-01-7040-007-A005AA

GENERAL

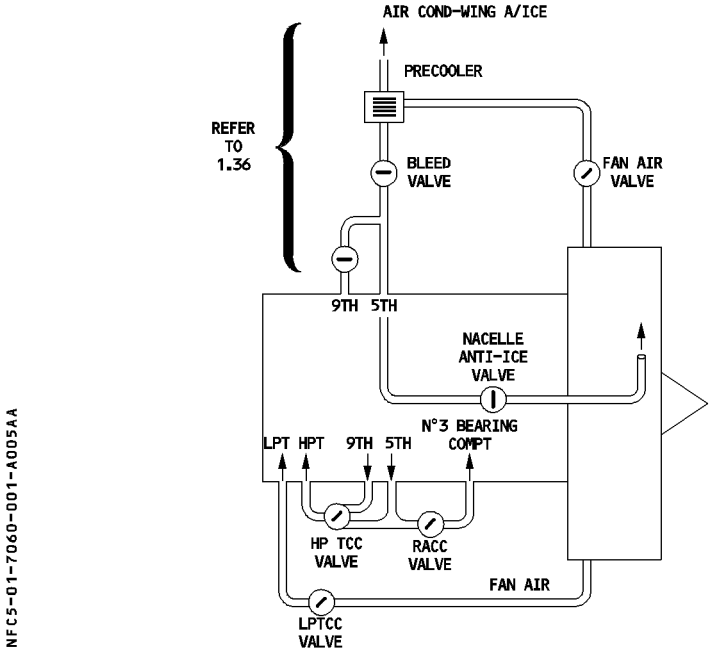
The oil system lubricates the engine components.
It contains :
– the oil tank
– the lube and scavenge pump modules
– the fuel/oil heat exchanger
– the filters, chip detectors, pressure relief and bypass valves.

FOR INFO



GENERAL

The air bleed system supplies the aircraft with compressed air.
It uses the air for :
– pneumatic system (refer to 1.36)
– cooling the engine compartment and the turbines.



COOLING

ROTOR ACTIVE CLEARANCE CONTROL (RACC) SYSTEM

The FADEC controls the RACC system through the HMU. The RACC system controls the clearance between the rotor blades of the HP compressor and its stator case.
The RACC system uses fifth-stage compressor bleed air that has been modulated according to the N2 and the flight parameters. The bleed air goes to the N°3 bearing compartment, where it is mixed with fan boost discharge.
Clearances are at the maximum when the RACC valve is closed.

HP TURBINE CLEARANCE CONTROL (HPTCC) SYSTEM

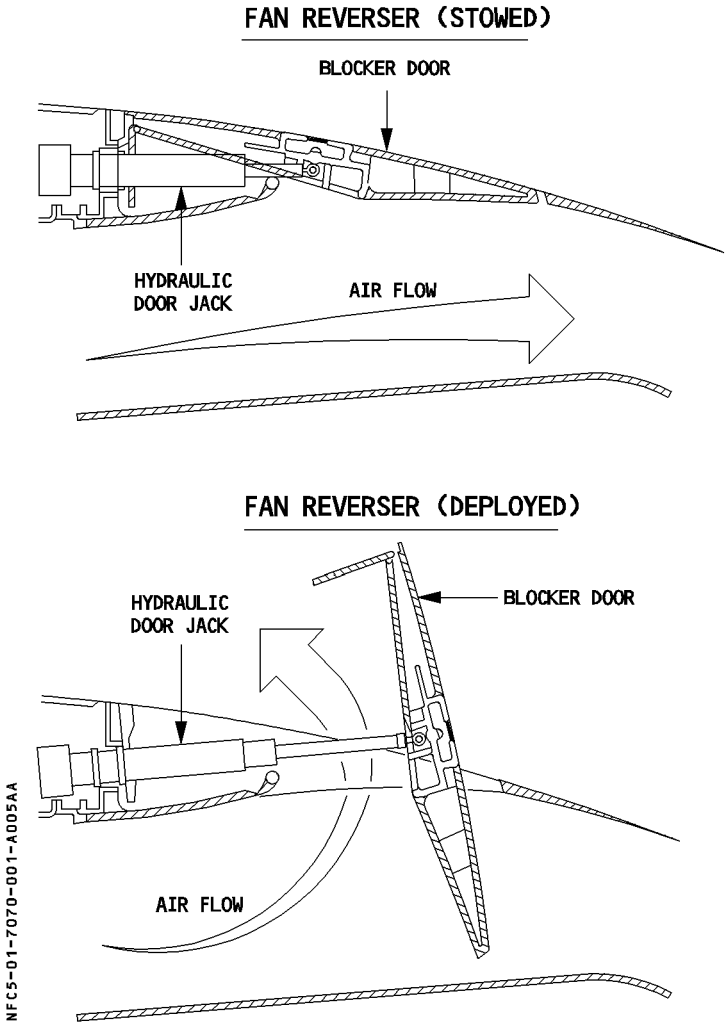
The FADEC controls the HPTCC system through the HMU. The HPTCC system controls the HP turbine clearance by modulating the HP compressor bleed air flow for cooling the HP turbine case.
It optimizes HP turbine performance and reduces exhaust gas temperature.

LP TURBINE CLEARANCE CONTROL (LPTCC) SYSTEM

The FADEC controls the LPTCC system through the HMU. The LPTCC system controls LP turbine clearance by modulating the fan bleed air flow for cooling the LP turbine case.

GENERAL

The aircraft reverses engine thrust by using four pivoting blocker doors on each engine to deflect the fan airstream.



A hydraulic door jack positions each door.
- The green circuit powers the doors on ENG 1.
- The yellow circuit powers the doors en ENG 2.

The associated FADEC controls the thrust reverser system. Each FADEC channel performs control and monitoring functions. The systems for the two engines are independent of each other.

The thrust reverser system on each engine has :

- 4 actuators,
- 4 latches,
- Door position switches,
- A Hydraulic Control Unit (HCU) that :
  - Pressurizes the thrust reverser hydraulic system,
  - Regulates the speed of the blocker doors, and
  - Supplies actuators with hydraulic power.
- A hydraulic shutoff valve which allows hydraulic pressure to the HCU.

Each pivoting door moves independently (the doors are not synchronized). The total actuation time is less than two seconds.

ACTUATION LOGIC

Deployment requires :

- One FADEC channel, operating with its associated throttle reverse signal ;
- Right and left main gear compressed signal from the corresponding LGCIUs ;
- A Thrust Lever Angle (TLA) reverse signals from at least one Spoiler Elevator Computer (SEC).

Before deployment is completed, the FADEC sets reverse idle thrust on the engine that is having its thrust reversed.

PROTECTION

- AUTO RESTOW FUNCTION

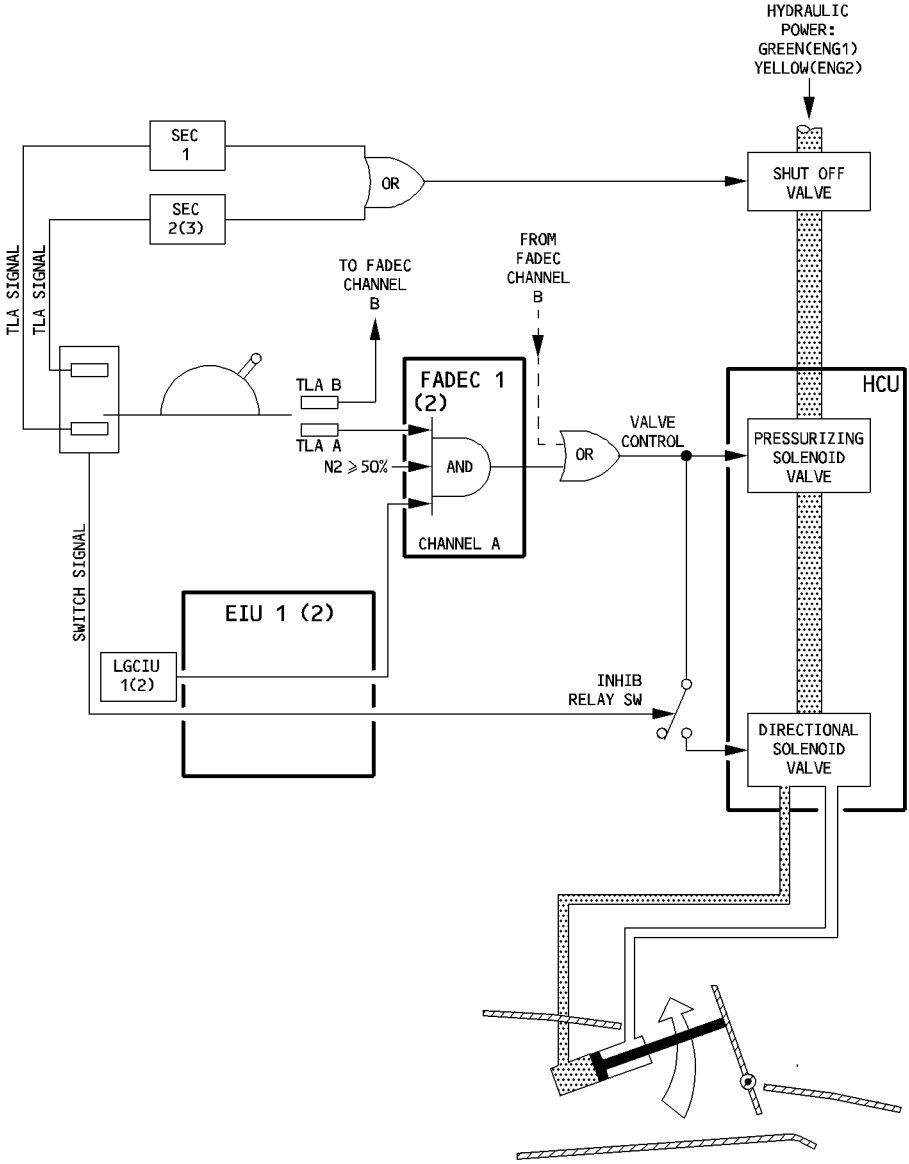
  The FADEC will automatically command the reverse to stow, if at least one door is unstowed and reverse thrust is not selected while the engine is running.

R Auto restow is totally inhibited in flight, and on ground, with N1 greater than 70 %.

- IDLE PROTECTION

  The FADEC will automatically select idle thrust if the reverse thrust is not selected and:
  - The four doors are detected unstowed, or
  - At least one door is detected unstowed, and hydraulic pressure is detected in the HCU (downstream of the pressurizing valve), or
  - The door position is indefinite, and hydraulic pressure is detected in the HCU (downstream of the pressurizing valve).

SCHEMATIC



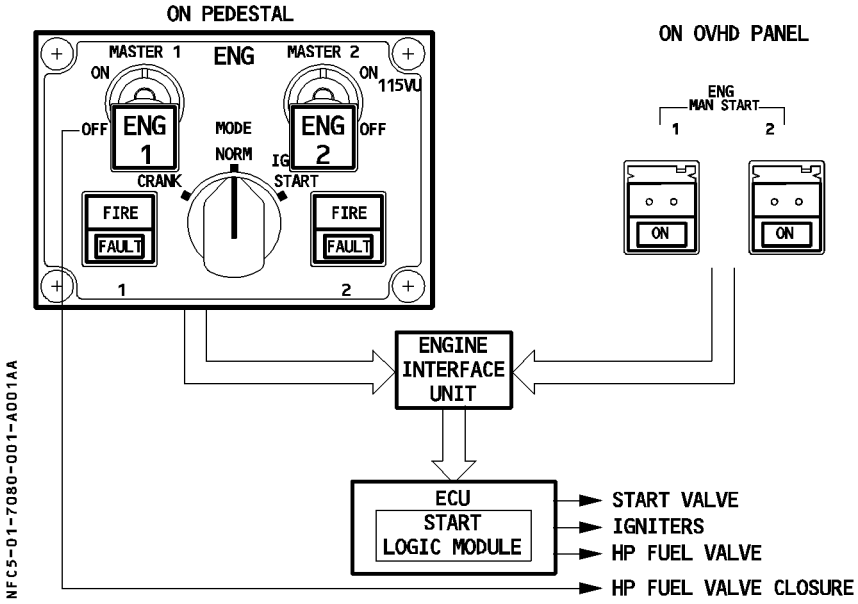
NFC5-01-7070-003-A106AB

GENERAL

The FADEC controls the ignition and starting system according to :
- the position of the engine start selector
- the position of the ENG MASTER switch
- the position of the ENG MAN START pushbutton switch
- the position of the ENG 1(2) ANTI ICE pushbutton switch
- the aircraft status (flight or ground).

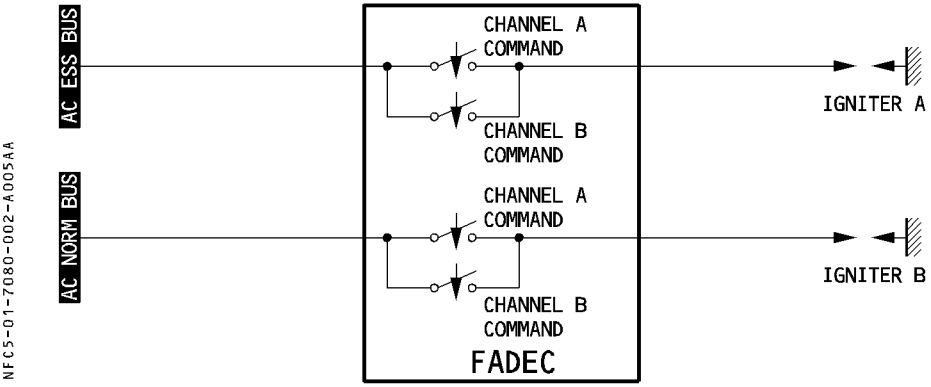
The FADEC receives its inputs from the Engine Interface Unit (EIU).

ARCHITECTURE



IGNITION SYSTEM

The ignition system is for engine starting on the ground and restarting in flight. It consists of two identical independent circuits for each engine, normally controlled by the FADEC channel A and channel B. Each FADEC channel can control both igniters.



Note : Supply for igniter A switches to the STAT INV BUS BAR as soon as the static inverter is operative.

IGNITION FOR STARTING

ON THE GROUND

- Automatic start
  - Only one igniter fires.
  - The FADEC automatically alternates the igniters used on successive starts following the sequence below :
    - channel A, igniter A
    - channel B, igniter A
    - channel A, igniter B
    - channel B, igniter B
  - The ignition comes on automatically when N2 reaches 16 % and cuts off automatically when N2 reaches 50 %.
- Manual start
  - Both igniters start firing when the MASTER switch is switched ON.
  - Both stop firing when N2 reaches 50 %.

IN FLIGHT

- Both igniters start firing when the MASTER switch is switched ON.

CONTINUOUS IGNITION

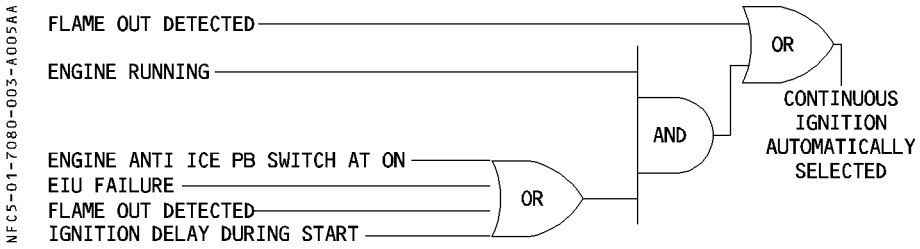
Continuous ignition is either selected manually or automatically to maintain engine combustion.

MANUAL SELECTION

In flight, continuous ignition is on when the ENG START selector is on IGN/START, if the corresponding engine is running.
Only one igniter is selected. If failed, both igniters are automatically selected.
On the ground after the engine is started, because ignition cuts off automatically, the flight crew must switch the ENG MODE selector to NORM then back to IGN/START to turn on continuous ignition.

AUTOMATIC SELECTION

R



ENGINE STARTING SYSTEM

GENERAL

The engine starting system consists of an air turbine starter and a start valve.
The start valve admits air supplied by the pneumatic system to operate the starter.
The FADEC controls the start valve electrically. If electrical control fails when the aircraft is on the ground, a handle allows the start valve to be operated manually.

AUTOMATIC STARTING

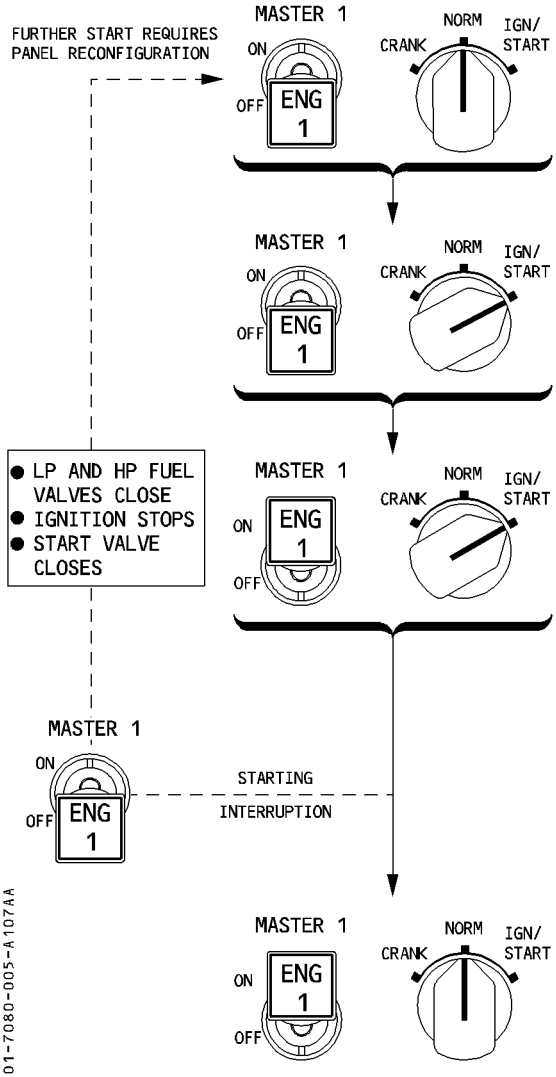
This sequence is under the full authority of the FADEC, which controls :
- the start valve
- the igniters
- the fuel HP valves

The FADEC :
- detects a hot start, a hung start, a stall, or no light up
- announces FAULT and identifies the fault in an ECAM message
- runs an abort sequence if a start aborts on the ground
  - closes the HP valve
  - closes the start valve
  - turns off ignition
  - cranks the engine crank after the start abort in order to clear out fuel vapors
  - controls any additional start attemps.

For an inflight start, the FADEC decides whether the engine is windmilling fast enough or needs assistance from the starter in view of current engine parameters and flight environment parameters.
Flight crew may interrupt this start sequence by moving the MASTER switch to OFF.

AUTOMATIC STARTING SEQUENCE

R



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(*) Note : If the ENG MASTER is not switched ON after 30 seconds, then the pack valve will reopen.

MANUAL STARTING

The FADEC has limited authority over manual starting controlling :

- the opening of the start valve when the ENG MODE selector is set to IGN/START and the MAN START pushbutton switch is pressed.
- the position of the HP fuel valve and the operation of both igniters, when the master switch is turned ON
- the closing of the start valve at 50 % N2, and, on the ground, the cutting off of ignition.

R The FADEC makes a passive survey of the engine during the starting sequence : the flight
R crew is made aware of an abnormal start by a proper ECAM warning and has to interrupt
R the start sequence. The FADEC has not the authority to abort the manual start :
R - in flight
R - on ground, except if the start EGT limit is exceeded before reaching 50 % N2. In this case
R only, the FADEC aborts the start.

Flight crew may interrupt the starting sequence :

- before the MASTER switch is set to ON, by switching the MAN START pushbutton switch to OFF
- after the MASTER switch set to ON, by switching the MAN START pushbutton and the MASTER switch to OFF (flight crew must perform a dry cranking cycle).

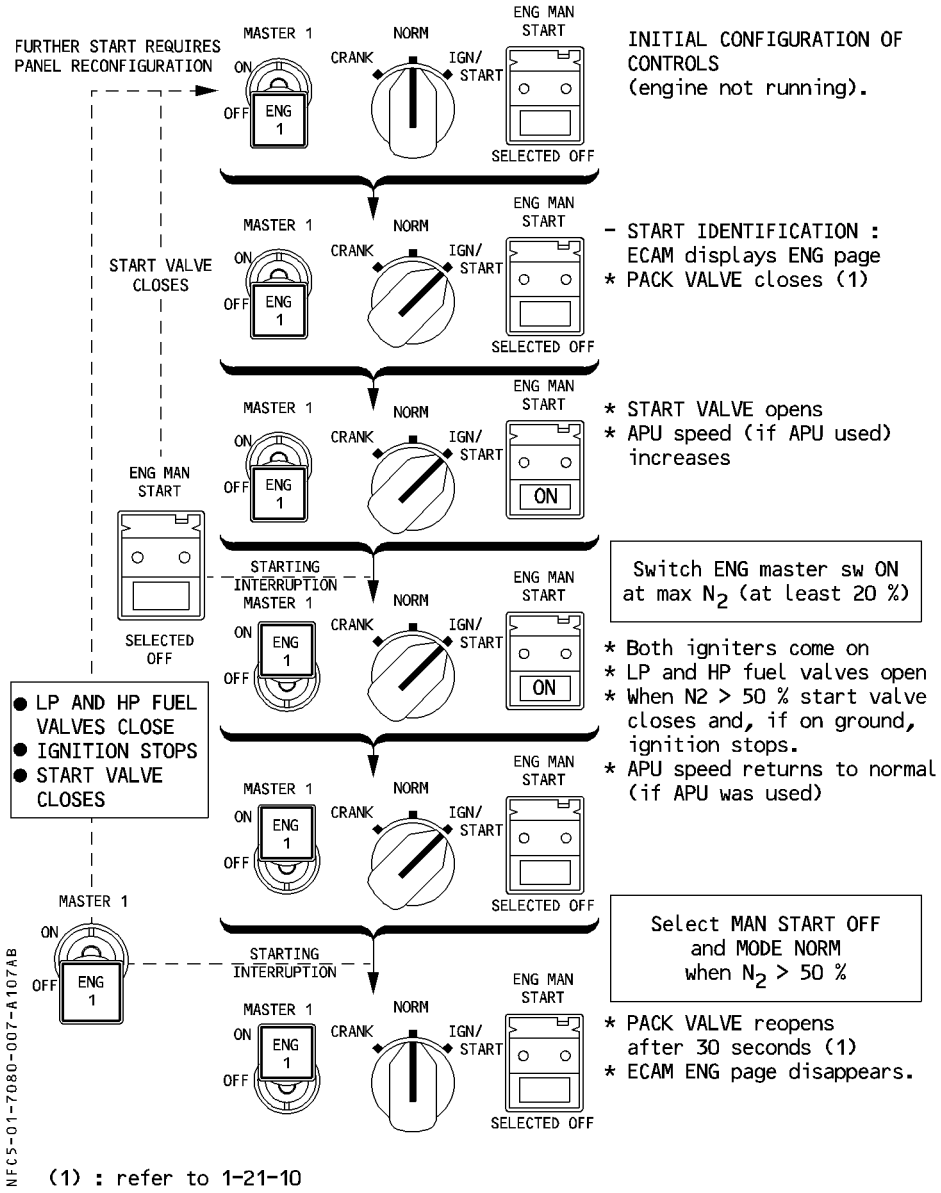
In flight, the FADEC always commands a starter-assisted air start.

ENGINE VENTILATION (dry cranking)

A dry cranking cycle ventilates the engine to remove fuel vapors after an unsuccessful start attempt on the ground.

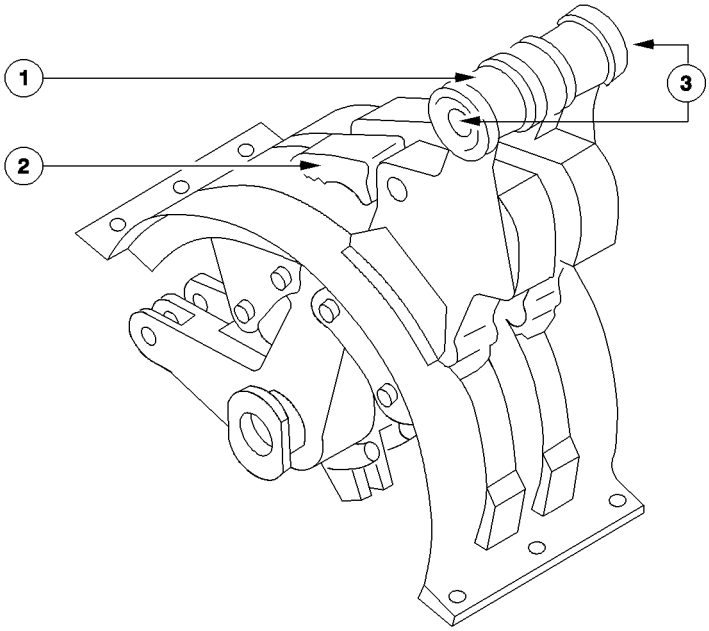
The flight crew can manually select cranking by setting the ENG MODE selector to CRANK and the MAN START pushbutton switch to ON (MASTER switch OFF). Flight crew can stop the cranking by setting the MAN START pushbutton switch to OFF.

MANUAL STARTING SEQUENCE



(1) : refer to 1-21-10

PEDESTAL



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(1) Thrust levers

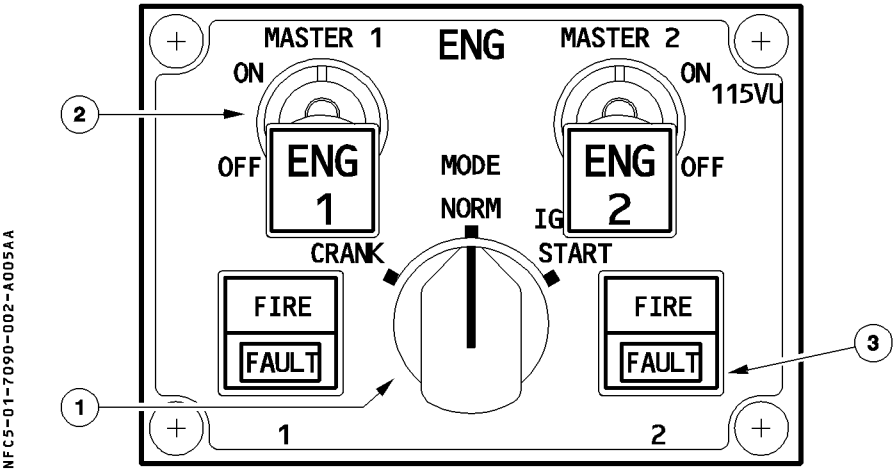
(Refer to 1.70.30).

(2) Reverser latching levers

These permit the pilot to override the stop at the forward idle position to select reverse thrust.
This stop resets when the pilot moves the lever back into the forward thrust area.

(3) Autothrust instinctive disconnect pb

(Refer to 1.22).



(1) ENG MODE selector

CRANK : The start valve opens, if the MAN START pushbutton switch is ON. Ignition does not fire.

NORM : This turns on continuous ignition (A and B) when the engine is running and :
- The engine anti-ice pushbutton switch is ON, or
- A flame-out is detected, or
- An EIU fails.

IGN START : If the MASTER switch is ON and N2 ≥ idle, this position selects continuous ignition (A and B).
- During an automatic start :
  - On the ground, when N2 passes 16 %, ignition switches to A or B. However, if there is an ignition delay during the start sequence, ignition is continuous (A and B).
  - In flight, continuous ignition (A and B) begins when the start sequence begins.
- During a manual start, ignition commences when the MASTER switch is turned ON.

R Pack valve closes automatically during the start sequence. (See 1.21.10).

Note : On the ground, the ignition cuts off automatically at the end of the start sequence (N2 > 50 %).

② ENG MASTER sw 1 (2)

ON : LP fuel valve opens (if the ENG FIRE pushbutton is in).
- During an automatic start, the HP fuel valve opens if :
  - The ENG MODE selector is at IGN/START.
  - N2 is above the following threshold :
    - 22 % on the ground
R - 15 % in flight
- During a manual start, the HP FUEL valve opens if :
  - The ENG MODE selector is at IGN/START.
  - The MAN START pushbutton switch is ON.

OFF : Close signals go directly to the HP fuel valve and the LP fuel valve. These signals cause both channels of the FADEC to be reset.

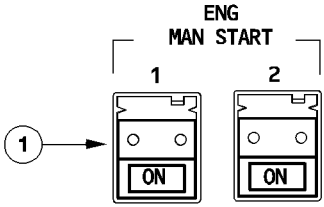
Note : Releasing the ENG FIRE pushbutton allows flight crew to shut down the engine by closing the LP fuel valve. There is a time delay of about 60 seconds at ground idle as the engine burns the fuel left between the LP valve and the nozzles.

③ FAULT lt 1 (2)

FAULT lt : This amber light comes on, and a caution appears on ECAM, if there is:
- an automatic start abort
- a disagreement between the HP fuel valve position and its commanded position.

OVERHEAD PANEL

NFC5-01-7090-004-A005AA



(1) ENG MAN START pb sw

ON : The start valve opens if the ENG MODE selector is set to CRANK or IGN/START and N2 < 20 %.
Both pack valves close during the start sequence.

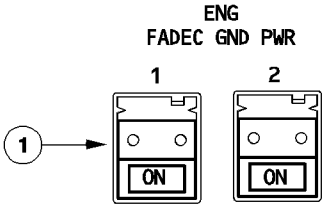
Note : The start valve closes automatically when N2 ≥ 50 %.

The blue ON light comes on.

Off : When the ENG MAN START pushbutton switch is set to OFF during a manual engine start, the start valve closes if the MASTER switch is OFF.

MAINTENANCE PANEL

NFC5-01-7090-004-B005AA



(1) FADEC GND PWR pb sw

ON : FADEC has electrical power on the ground if the ENG FIRE pushbutton is not released.

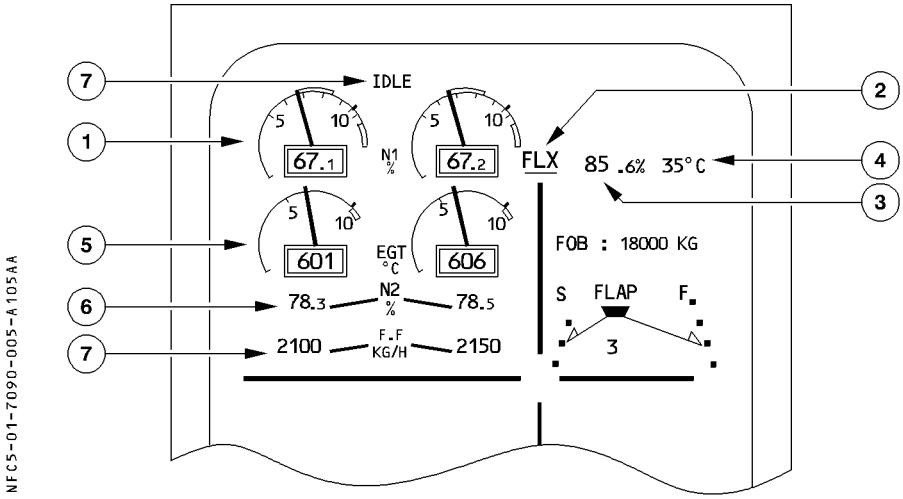
ECAM

GENERAL

The upper ECAM E/WD permanently displays the engines' primary parameters. The lower ECAM SD displays the secondary parameters, either when they are selected automatically by the system, or manually by the flight crew.

PRIMARY PARAMETER

R



(1) LP rotor speed (N1)

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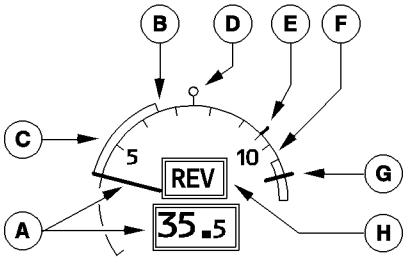


(A) Actual N1 : the N1 needle and N1 digital indication are normally green.
The needle pulses amber when the actual N1 is above the N1 MAX (see (E)).
The needle pulses red when the actual N1 is above the red line N1 (104 %).
When N1 is degraded (in case both N1 sensors fail), the last digit of the digital display is amber dashed.

(B) N1 Command : this N1 corresponds to the demand of the autothrust system (A/THR), as limited by the position of the thrust lever. It is displayed only if A/THR is on.

(C) Transient N1 : this blue arc shows the difference between the actual N1 and the N1 commanded by the A/THR. It is displayed only if the A/THR is on.

(D) N1 TLA : this small white circle shows the N1 corresponding to the thrust lever position.

(E) Max N1 : this amber index shows the N1 the engine would produce with the thrust lever all the way forward.

(F) Max permissible N1 : this red arc, showing the prohibited or "redline" area of operation, begins at 104 %.

(G) N1 exceedance : if N1 exceeds 104 % during a flight, this red mark appears and remains at the highest N1 attained. It disappears after a new start on the ground or after maintenance action through the MCDU.

(H) REV : appears in amber when any one blocker door is unstowed or unlocked.
It changes to green when all four blocker doors are fully deployed.
(If a door unlocks in flight the indication first flashes for 9 seconds, then remains steady).

(2) Thrust limit mode

TOGA, FLX, CL, MCT, or MREV limit mode, selected by the position of whichever thrust lever is farther forward, is displayed in blue.

(3) N1 rating limit

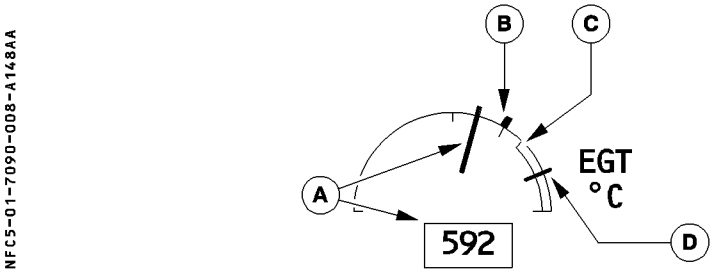
It is computed by the FADEC for the present thrust lever angle, and is displayed in green.

Note : When the aircraft is on ground with the engines running, the N1 rating limit displayed here corresponds to the TOGA thrust limit, regardless of the thrust lever position.
When the aircraft is on ground with the engines running and FLEX mode is selected, this number is the FLEX N1, regardless of the thrust lever position between idle and FLX/MCT.

R (4) FLEX temperature

R If FLX mode is selected, the flexible takeoff temperature selected through the MCDUs is
R displayed in blue.

R (5) EGT indicator



(A) Actual EGT
- It is normally green.
- It pulses amber above 915° C except for high power operation (FLEX TO or thrust lever above MCT or at MAX REV, or activation of alpha floor).
- It pulses amber above 725° C during start sequence.
- It pulses red above 950° C, and the numerical value becomes red.

(B) Max EGT
The amber index appears at 725° C during engine start, then at 915°C.

(C) Max permissible EGT
The EGT red line is at 950° C. Display shows red arc from 950° C to the end of the scale.

(D) EGT exceedance
If the EGT goes over 950°C, a red mark appears at its maximum value. It disappears after a new takeoff, or after a maintenance action through the MCDU.

R (6) HP rotor speed N2

The numbers are normally green. (During the start sequence, they are green on a grey background).
When N2 is above 105 %, the indication turns red and a red cross appears next to it.
When the N2 value is degraded (if both N2 sensors fail), the last digit is amber and is dashed.

R (7) Fuel flow

These numbers are green.

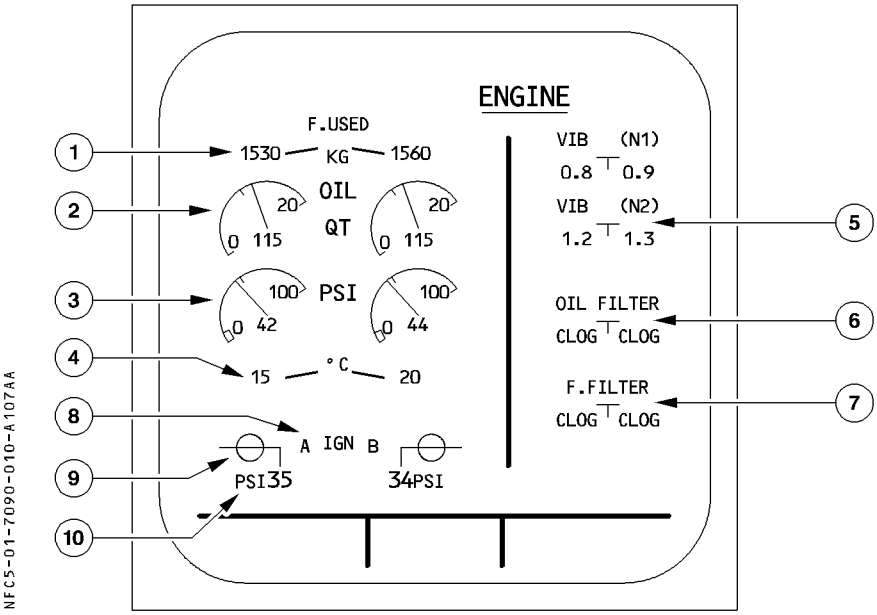
Note : If the system detects a discrepancy between the N1, N2, EGT and fuel flow values on the FADEC-DMC bus and the corresponding displayed values, an amber CHECK appears underneath the affected parameter.

R (8) IDLE indication

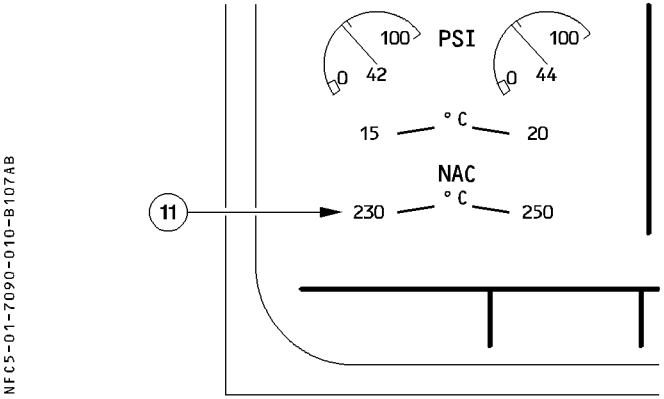
This legend appears in green when both engines are at idle. It flashes for 10 seconds, then remains steady.

SECONDARY PARAMETERS

NORMAL CONFIGURATION



R ONE NAC TEMPERATURE ABOVE 240° C
R



(1) Fuel used

The green number is the fuel used as computed by the FADEC.
It resets when the engine starts (MASTER switch ON) on the ground.
It is frozen at its last value (until the next engine start) when the engine shuts down. (The ECAM CRUISE page also displays it).
The two last digits are dashed if the fuel-used indication is inaccurate due to the loss of fuel flow data for more than one minute.

(2) Oil quantity

The needle and the numbers are normally green.
The indication pulses when oil quantity goes below three quarts (decreasing) or above five quarts (increasing).

(3) Oil pressure

The needle and the numbers are normally green.
The digital indication pulses if :
– oil pressure exceeds 90 psi (increasing) or 85 psi (decreasing).
– oil pressure drops below 16 psi (decreasing) or 20 psi (increasing).
The indication turns red and a warning appears on ECAM if the oil pressure drops below 13 psi.

(4) Oil temperature

These numbers are normally green.
They pulse above 140°C (increasing) or 135° C (decreasing).
They turn amber and a warning appears on ECAM if the temperature exceeds :
– 140° C for more than 15 minutes, or
– 155° C without delay.

(5) VIB

The legend is green.
VIB N1 pulses above 6.
VIB N2 pulses above 4.3.
(These numbers also appear on the ECAM CRUISE page).

Note : An MCDU procedure may reduce the advisory threshold to the level of vibration reached during the last flight.
If this function has been activated, the N1 and N2 VIB indications pulse below 6 and 4.3, respectively.

⑥ Oil filter clog

CLOG appears in amber if there is excessive pressure loss across the main oil scavenge filter.

⑦ Fuel filter clog

CLOG appears in amber if there is excessive pressure loss across the fuel filter.

⑧ Ignition

IGN appears in white during the start sequence.
The letters A, B or AB appear in green when the respective igniters are firing.

⑨ Start valve position

⊖ Green : valve fully open.
⦶ Green : valve fully closed.

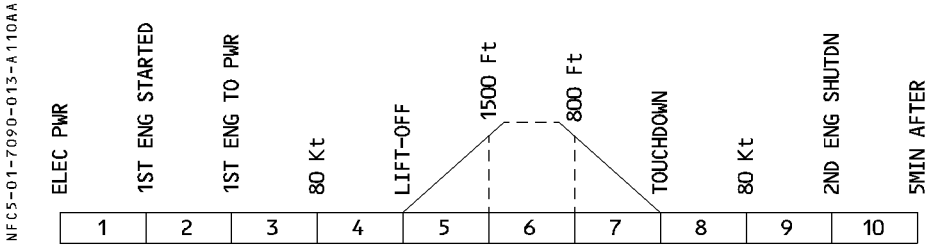
⑩ Engine bleed pressure

The green numbers show the bleed pressure upstream of the precooler.
They become amber when the pressure drops below 21 psi with N2 ≥ 10 % or if there is an overpressure.

⑪ Nacelle temperature

The screen displays both nacelle temperatures if at least one of them is above 240°C.
A nacelle temperature above 240° C pulses green.
During the start sequence, an ignition indication replaces these temperatures.

WARNINGS AND CAUTIONS



R

E / WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
ENG DUAL FAILURE	CRC	MASTER WARN	ENG	Associated with GEN FAULT lts and PACK FAULT lt	NIL
ENG 1(2) OIL LO PR Oil low pressure triggered at 13 psi by the oil press switch.				NIL	1, 10
ENG STALL	SINGLE CHIME	MASTER CAUT		Associated FAULT lt on ENG panel on pedestal (exception case of starter time exceeded)	3, 4, 5, 7, 8
ENG 1(2) HP FUEL VALVE HP fuel valve failed closed.					3, 4, 5, 6, 7, 8
ENG 1 (2) START FAULT Start fault due to : No light up, or . Eng stall or overtemp (above 725°C), or . Starter time exceeded . Thrust lever not at idle . Low start air press					3, 4, 5, 7, 8
ENG 1(2) START VALVE FAULT Position disagree.					4, 5, 8
ENG 1 (2) THR LEVER DISAGREE Disagree between both resolvers of a thrust lever.				NIL	4, 5, 7, 8
ENG 1(2) OIL HI TEMP Oil temp between 140 and 155° C for more than 15 min, or oil temp above 155° C.					4, 5, 6, 7, 8, 9, 10
ENG 1(2) FADEC FAULT Both channels failed.					1, 2, 3, 4, 8, 9, 10
ENG 1(2) LOW N1 No N1 rotation during start.					1, 4, 5, 6, 7, 8, 10
ENG THRUST LOCKED Thrust levers are not moved within 5 sec, following an unvoluntary disconnection of the A/THR (or disconnection through the FCU pb).	SINGLE CHIME every 5 sec	MASTER CAUT every 5 sec	NIL		3, 4, 5 7, 8
ENG FLEX TEMP NOT SET Flex temp has not been entered on the MCDU.	SINGLE CHIME	MASTER CAUT			3 to 10
ENG 1(2) FADEC HI TEMP					
ENG TYPE DISAGREE Rating discrepancy between the two engines.					

R

E / WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
ENG 1(2) THR LEVER FAULT Both resolvers on one thrust lever have failed.	SINGLE CHIME	MASTER CAUT	NIL	NIL	5
ENG 1(2) FAIL Eng core speed below idle, with master sw ON and fire pb not pushed.					1, 10
ENG 1(2) SHUT DOWN Eng master at off in phases 3 to 8, or eng fire pb pushed in phases 1, 2, 9 and 10.					
ENG 1(2) REVERSE UNLOCKED One or more reverser doors not locked in stowed position in flight, or on ground with no deploy order.					8
ENG 1(2) REV PRESSURIZED Reverser system is pressurized, while rev doors are stowed and locked with no deploy order.					4, 5, 8
ENG 1(2) COMPRESSOR VANE Variable bleed valve sys or variable stator vane sys fault.					4, 5, 7, 8
ENG 1(2) N1 or N2 or EGT OVER LIMIT N1 above 104 % N2 above 105.0 % EGT above 950°C					4, 8
ENG 1(2) IGN A + B FAULT Both ignition circuits are failed.					3, 4, 5, 7, 8
ENG 1(2) CTL VALVE FAULT Burn stag valve failure or HPTC, or RAC system failure.					4, 5, 7, 8
ENG 1(2) FUEL CTL FAULT Fuel metering valve position disagree.					
ENG 1(2) SENSOR FAULT PS 3 or T 25 or T3 or N1 or N2 data unavailable on both channels.					
ENG 1(2) PROBES FAULT T 12 or PO PT 2 data unavailable on both channels.					
ENG 1(2) N1 (N2, EGT, FF) DISCREPANCY Discrepancy between real and displayed values.					3, 4, 5, 8
ENG 1(2) BLEED STATUS FAULT Bleed, X Bleed, pack, anti-ice valve position status not received by FADEC active channel.					3, 4, 5, 7, 8
ENG 1(2) FUEL FILTER CLOG	NIL	NIL	ENG		4, 5, 7, 8
ENG 1(2) OIL FILTER CLOG					
ENG VIB SYS FAULT Failure of vibration detection system.			NIL		3, 4, 5, 6, 7, 8, 9
ENG 1(2) OVSPD PROT FAULT Loss of overspeed protection.					4, 5, 7, 8
ENG 1(2) IGN A(B) FAULT Ignition circuit A or B failed.					3, 4, 5, 7, 8
ENG 1(2) FADEC ALTERNATOR Loss of electrical auto supply of either FADEC channel.					
ENG COMPRESSOR VANE Engine 1 and 2 VBV or VSV fault.					
ENG 1(2) FUEL RETURN VALVE Fuel return valve is failed in the not open, or not closed position.					

E / WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
ENG 1(2) FADEC A(B) FAULT one FADEC channel failed					4, 5, 7, 8
ENG 1(2) EIU FAULT Data bus between EIU and ECU failed.	NIL	NIL	NIL	NIL	1, 3, 4, 5, 7, 8, 10
ENG 1(2) REVERSER FAULT loss of thrust reverser on one engine due to system components or input faults					3, 4, 5
ENG 1(2) REV ISOL FAULT	SC	CAUT			3 to 7
ENG 1(2) REV SWITCH FAULT failure of reverser permission switch	NIL	NIL			3, 4, 5, 6, 7, 8
ENG 1(2) FUEL RETURN VALVE Failure of the fuel return valve in open or closed position					3, 4, 5, 7, 8
ENG 1(2) ONE TLA FAULT					3, 4, 5, 6, 7, 8

MEMO DISPLAY

IGNITION appears in green when the continuous ignition is activated on either engine.

BUS EQUIPMENT LIST

R

			NORM		EMER ELEC		
			AC	DC	AC ESS	DC ESS	HOT
FADEC	CHANNEL A	ENG 1 and 2				X	
	CHANNEL B	ENG 1		BAT			
		ENG 2		DC2			
EIU		ENG 1		BAT		X	
		ENG 2				X	
HP VALVES						X	
LP VALVES				DC2		X	
OIL PRESS/QTY		ENG 1		DC1			
		ENG 2		DC2			
IGNITION	A	ENG 1 and 2	AC ESS		AC ESS or AC STAT INV during RAT extension		
	B	ENG 1	AC1				
		ENG 2	AC2				
EVMU		ENG 1 and 2	AC1				