70.00 CONTENTS

GENERAL

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

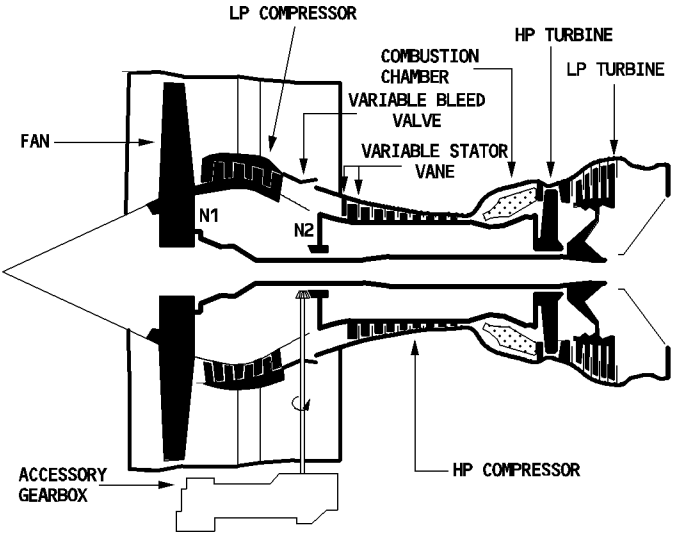
DESCRIPTION

– **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 five-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.

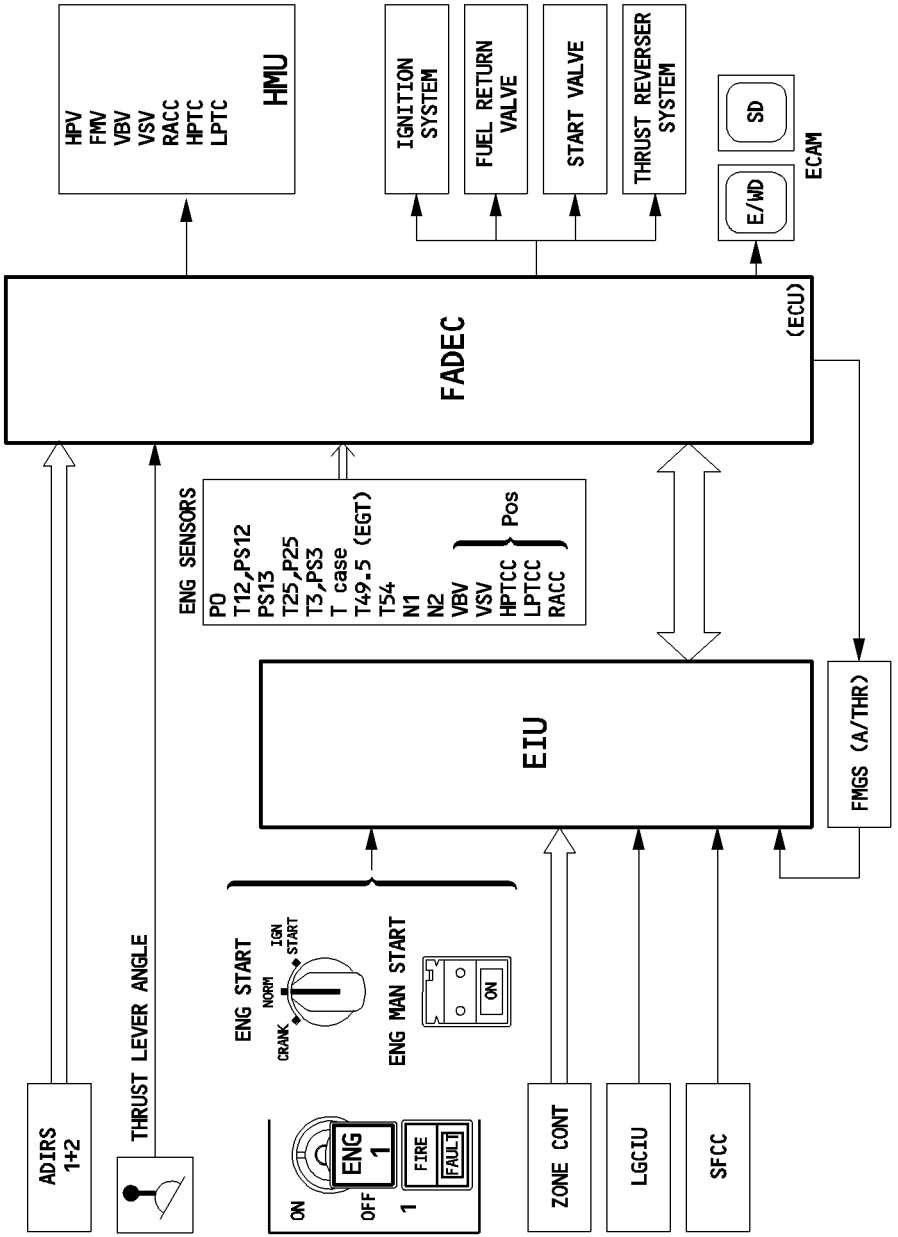
– **Accessory gearbox**
The accessory gearbox, located at the bottom of the fan case, receives torque from horizontal HP rotor drive shaft and drives gearbox mounted accessories such as : IDG, hydraulic pump, oil pump, engine driven pump, HMU and electrical generator for the FADEC.



FFC5-01-7010-001-A005AA

GENERAL

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


HMU
HPV
FMV
VBV
VSV
RACC
HPTC
LPTC
IGNITION SYSTEM
FUEL RETURN VALVE
START VALVE
THRUST REVERSER SYSTEM
SD
E/WD
ECAM
FADEC
(ECU)
ENG SENSORS
P0
T12,PS12
PS13
T25,P25
T3,PS3
T case
T49.5 (EGT)
T54
N1
N2
VBV
VSV
HPTCC
LPTCC
RACC
Pos
EIU
FMGS (A/THR)
ENG START
NORM
IGN START
CRANK
ENG MAN START
ON
ON
OFF
1
ENG 1
FIRE
FAULT
ADIRS 1+2
THRUST LEVER ANGLE
ZONE CONT
LGCIU
SFCC
FFCS-01-7020-002-A005AD

FUNCTIONS

The FADEC system performs the following functions:

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

R **Protection against engine exceeding limits**
- protection against N1 and N2 overspeed

R - 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 (ATS demand).

Automatic engine starting sequence
- control of :
  - the start valve
  - the HP fuel valve
  - the fuel flow
  - the ignition
- monitoring of N1, N2, FF and EGT

R - initiation of abort and recycle (on the ground only).

Manual engine starting sequence

R - passive monitoring of engine
- active protection (on ground only) against high EGT and for starter reengagement speed
- 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
- secondary engine parameters (oil temperature, nacelle temperature, oil filter clog and fuel filter clogging)

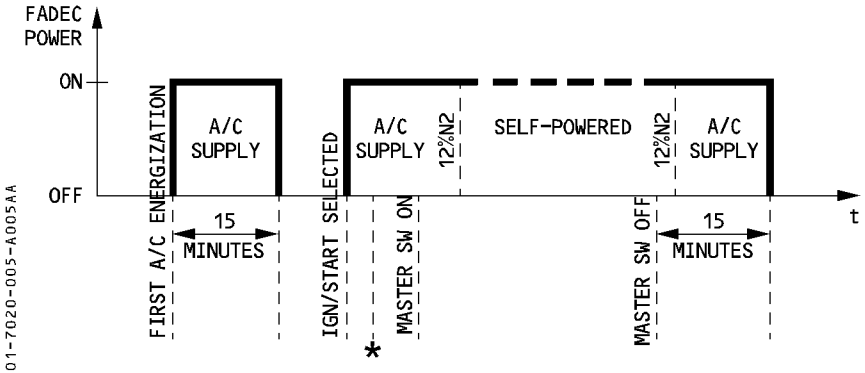
Computation of fuel used
- integration of fuel flow.

Detection, isolation, and recording of failures

POWER SUPPLY

The FADEC system is
- powered by the aircraft electrical circuit below 15 % N2
- self-powered above 12 % N2.
- both supplies are connected between 12 and 15 %.

R FADEC ELECTRICAL SUPPLY LOGIC

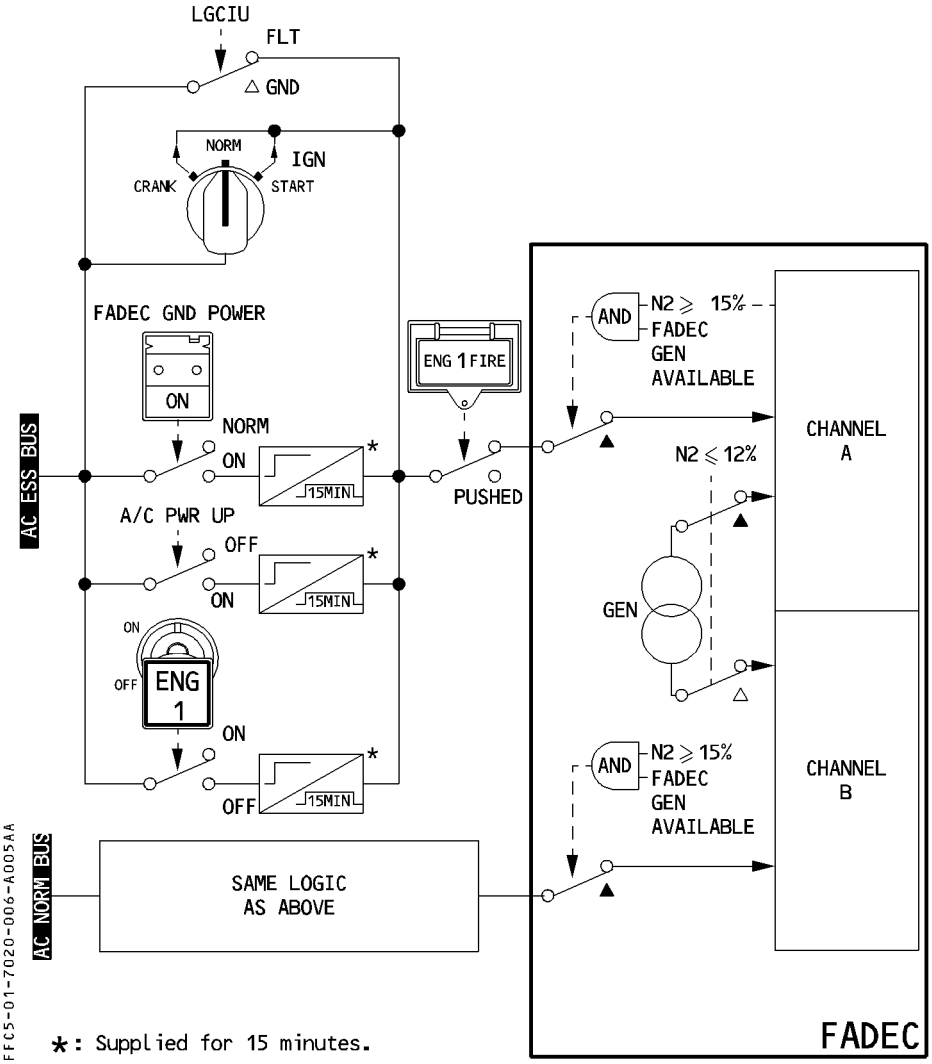


*: if ENG START Sel is set to NORM position before engine start,FADEC supply is cut off

FADEC POWER SUPPLY

FOR INFO

R

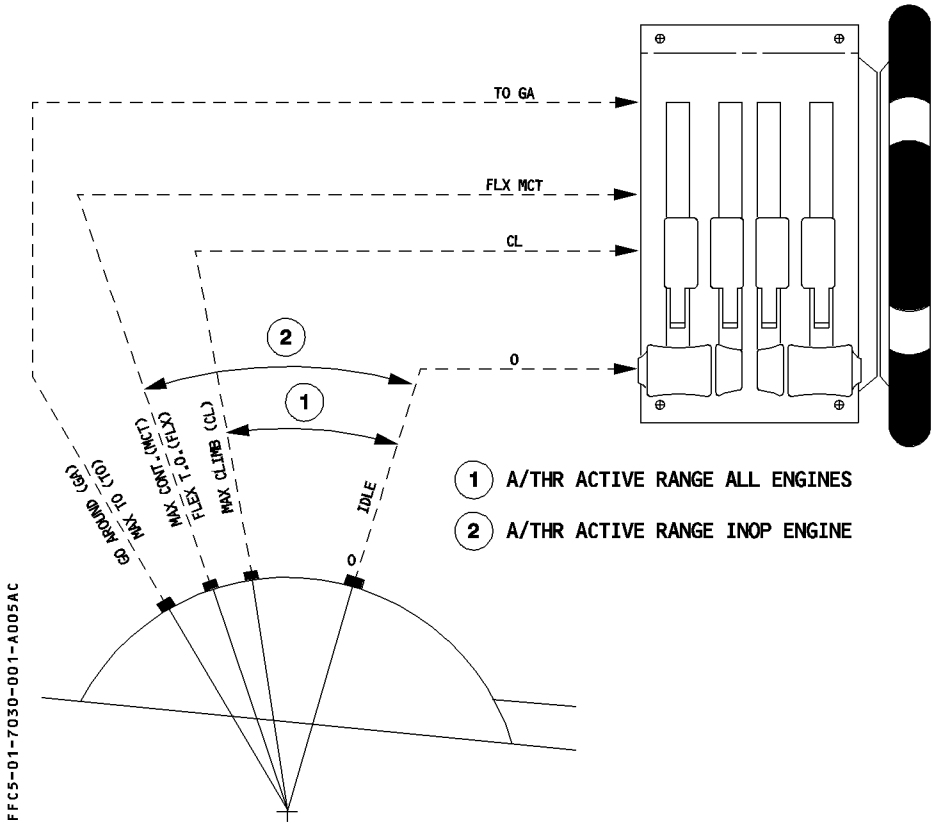


FF65-01-7020-006-A005AA

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

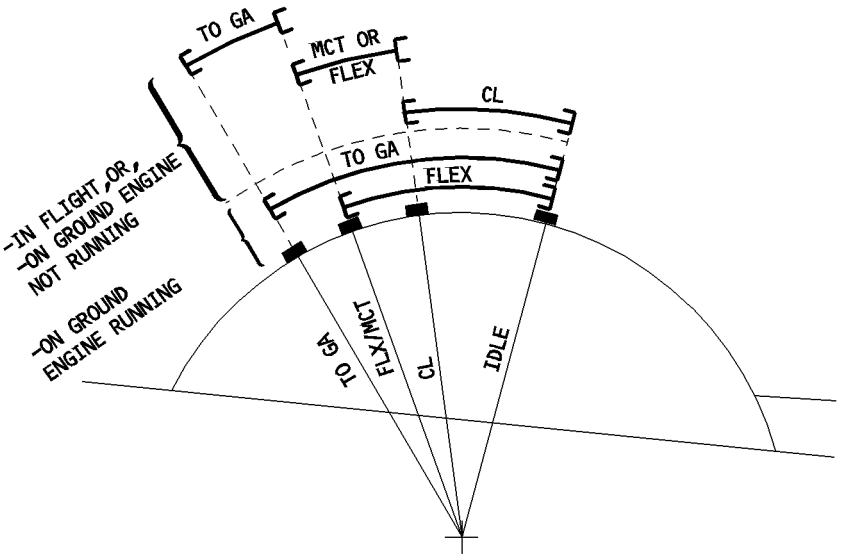


The thrust levers can only be moved manually.
The rang of movement is divided into 3 operating segments.
Thrust lever position is transmitted to the FADEC which computes and displays the thrust rating limit and the N1 TLA.

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.

N1 RATING LIMITS :

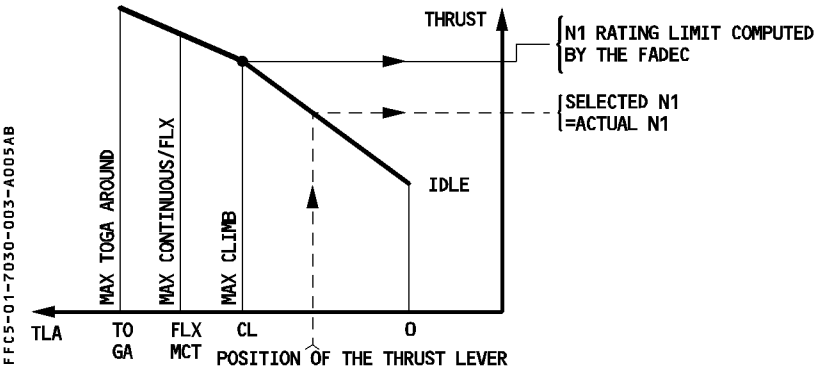


FFC5-01-7030-002-A005AB

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 the thrust by moving the thrust lever from IDLE to TO GA 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 this 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 MCDU has selected a flex takeoff temperature that is higher than the current total air temperature (TAT). Otherwise the engine produces maximum continuous thrust (MCT).

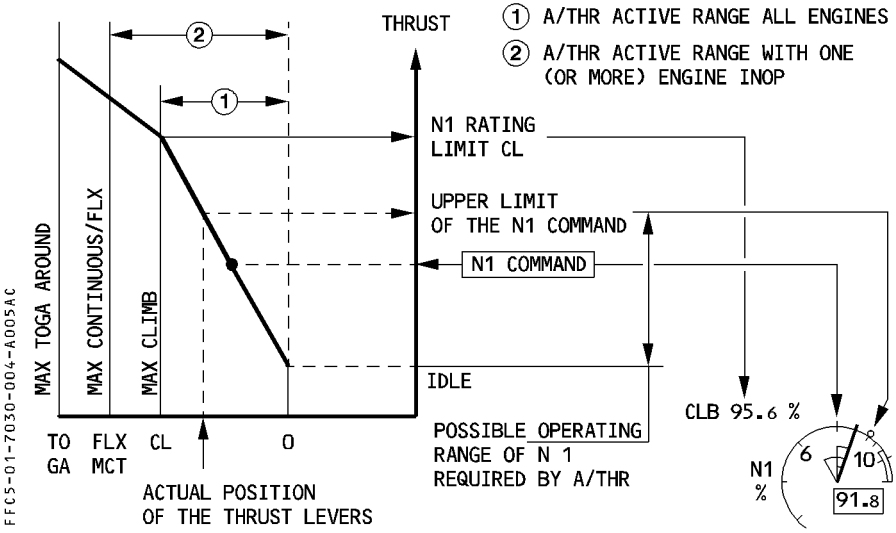
Note : A change of FLEX TEMP during the takeoff has no effect on the thrust.

– **After take-off :**
The pilot can change from FLX to MCT by moving the thrust lever to TO GA or CL, then back to MCT. After that, he cannot use the FLX rating.
The pilot can always get MAX TO thrust by pushing the thrust lever all the way forward.

Note : Setting the thrust lever out of FLX MCT detent without reaching TO GA or CL detent has no effect.

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).



R INDICATIONS ON FMA

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

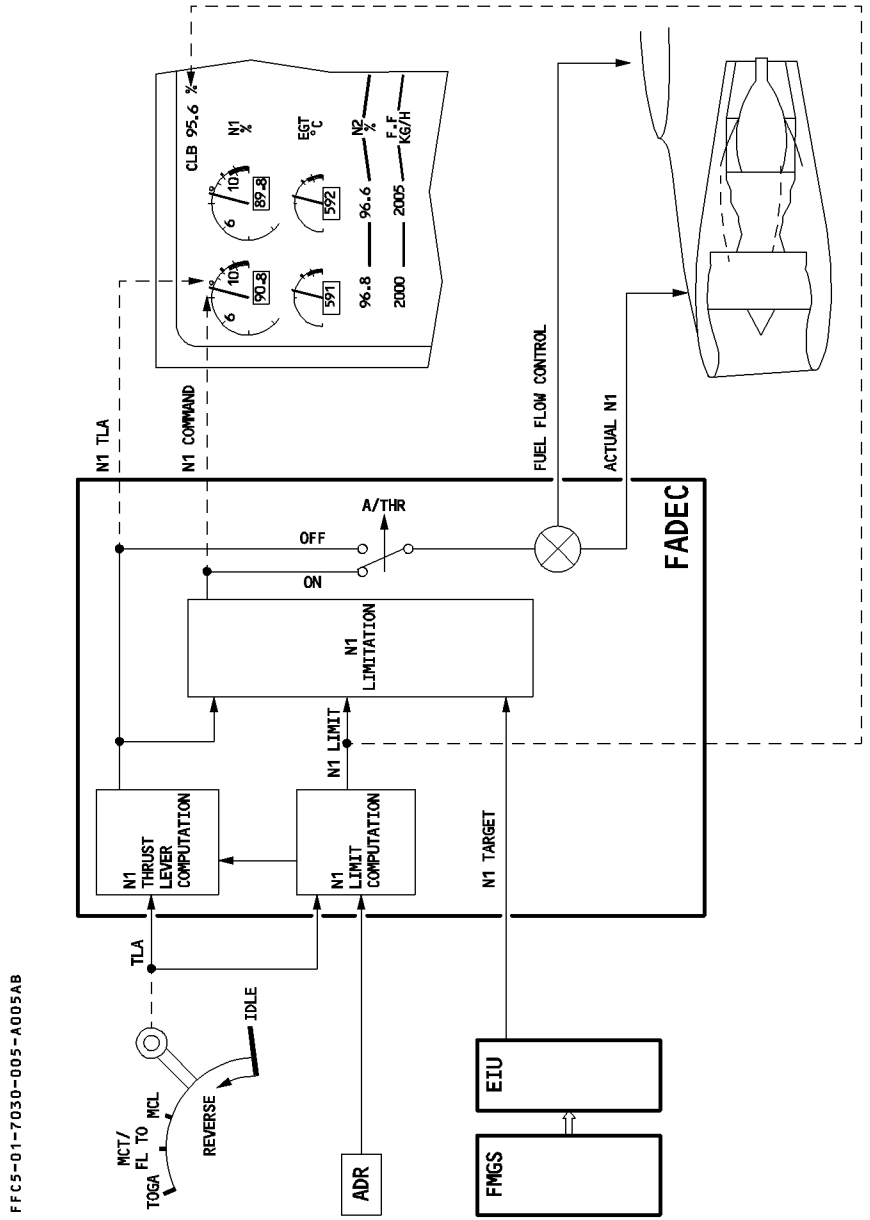
LVR ASYM : Appears in amber (third line on the FMA) if, with the A/THR active and all engines running, one, two or three thrust levers are set out of the CLB notch.

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

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

THR LK : Flashes amber (third line on the FMA) after A/THR disconnection (pilot action or failure) resulting in the thrust being frozen.

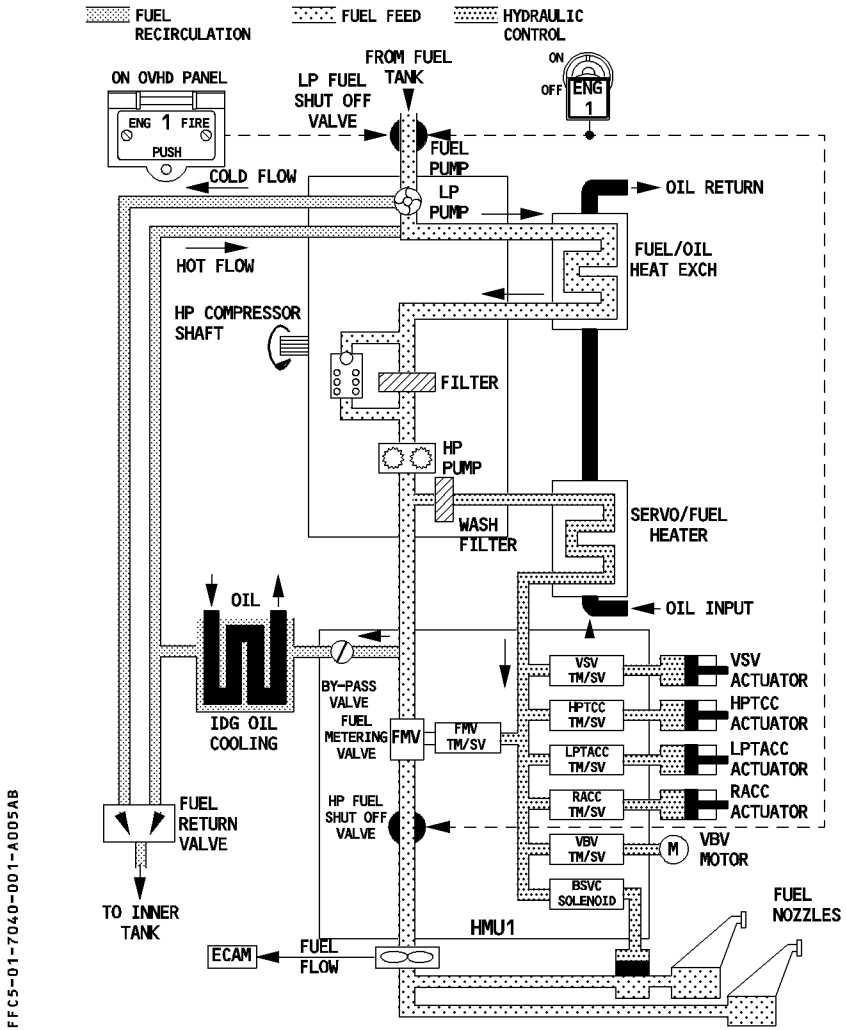
THRUST CONTROL



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 exhanger, 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 hydromechanical unit (HMU), and an unfiltered flow for the metering valve of the HMU.

SHUT-OFF VALVES

Moving the ENG 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.

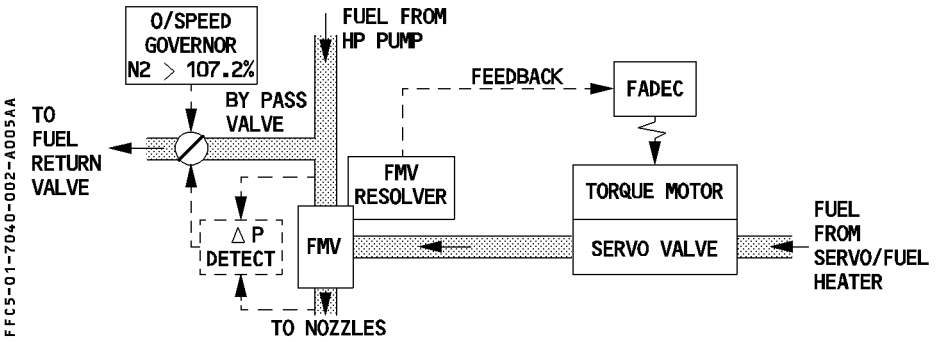
HYDROMECHANICAL UNIT

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

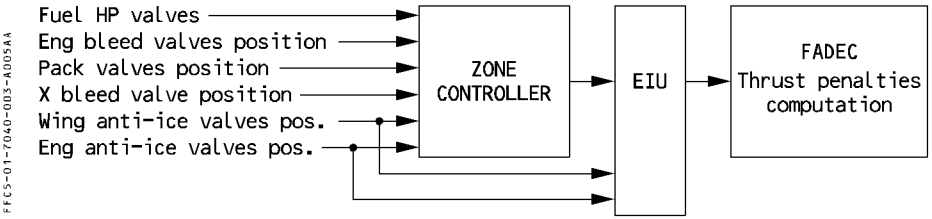
FOR INFO

The Fuel Metering Valve (FMV) transforms FADEC orders through a torque motor and servovalve 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 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 max N1 and N2 ;
- Maintain the air bleed pressure requirement.

The FADEC computes the 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
  - Oil temperature
  - Mach number.
- Is selected :
  - In flight, when the flaps are retracted and the gear is up.
  - On ground, provided reverse is not selected.

Approach idle

R
- Is regulated according to aircraft altitude, regardless of bleed system demand.
- Selected in flight, when the FLAPS are extended to FLAP 2, FLAP 3, or FULL, or when the landing gear is down.
- Allows the engine to rapidly accelerate from idle to go-around thrust.

Reverse idle

- Selected on ground, when reverse idle thrust is selected.
- 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 (VSVs)***
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.
VSV are fully closed during engine start and are fully open at high thrust.

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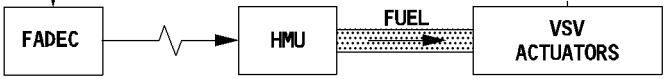

– ***Variable Bleed Valves (VBVs)***
The FADEC controls the VBVs, upstream of the HP compressor. Their setting depends on compressor inlet temperature and on N2. It varies between full open (start, low thrust, and during fast deceleration) and full closed (high thrust) positions.

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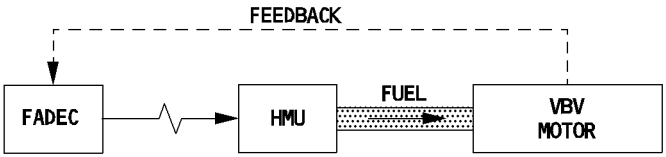


FOR INFO

Burner Staging Valve (BSV) :

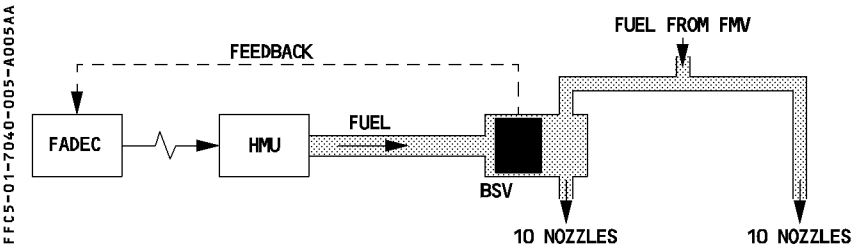
The FADEC controls the BSV, which allows fuel to go to either 10 or 20 fuel nozzles :

· 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.

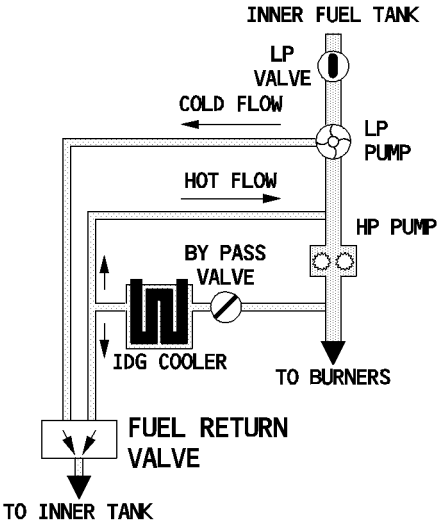
If the fuel control system fails, an internal safety system ensures that all nozzles are supplied.



IDG OIL COOLING SYSTEM

Fuel flow from the HMU is partly used as a cooling agent for the IDG oil system ; it then returns to the fuel pump unit or to the tank.

FOR INFO



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Fuel for IDG cooling is tapped downstream of the HP pump.
It goes through the integrated drive generator (IDG) heat exchanger (where it absorbs heat).
A part of the fuel is returned upstream of the HP pump.
The other part is returned to the inner tank when the fuel return valve is controlled open by the FADEC.
A cold flow (from the LP pump) is mixed to the hot flow returning to the tank to reduce returning fuel temperature.

RECIRCULATION FUEL FLOW CONTROL LOGIC

The FADEC controls the fuel flow to the tank through the fuel return valve, according to the engine oil temperature (which is dependent on the IDG oil temperature). There are two levels of recirculation.
The flow also depends on the inner tank fuel temperature and the flight/ground condition.
At low engine power if oil temperature still increases the FADEC increases the modulated idle.

ON GROUND

A fuel flow of 500 kg/hr is recirculated when the engine oil temperature reaches 95°C. It is stopped when the temperature decreases to 83°C. When the temperature is above 95°C, the idle speed is increased.

IN FLIGHT WITH INNER TANK FUEL TEMPERATURE ABOVE 15°C

A fuel flow of 500 kg/hr is recirculated when the engine oil temperature reaches 95°C. It is stopped when the temperature decreases to 83°C.
The fuel flow is increased to 830 kg/hr when the temperature reaches 100°C. It is reduced to 500 kg/hr when the temperature decreases to 90°C.
When the temperature is above 100°C the idle speed is increased.

IN FLIGHT WITH INNER TANK FUEL TEMPERATURE BELOW 15°C

A fuel flow of 830 kg/hr is recirculated when the engine oil temperature reaches 50°C.
It is stopped when the temperature decreases below 40°C.
When the temperature is above 50°C, the idle speed is increased.

FUEL RECIRCULATION INHIBITION

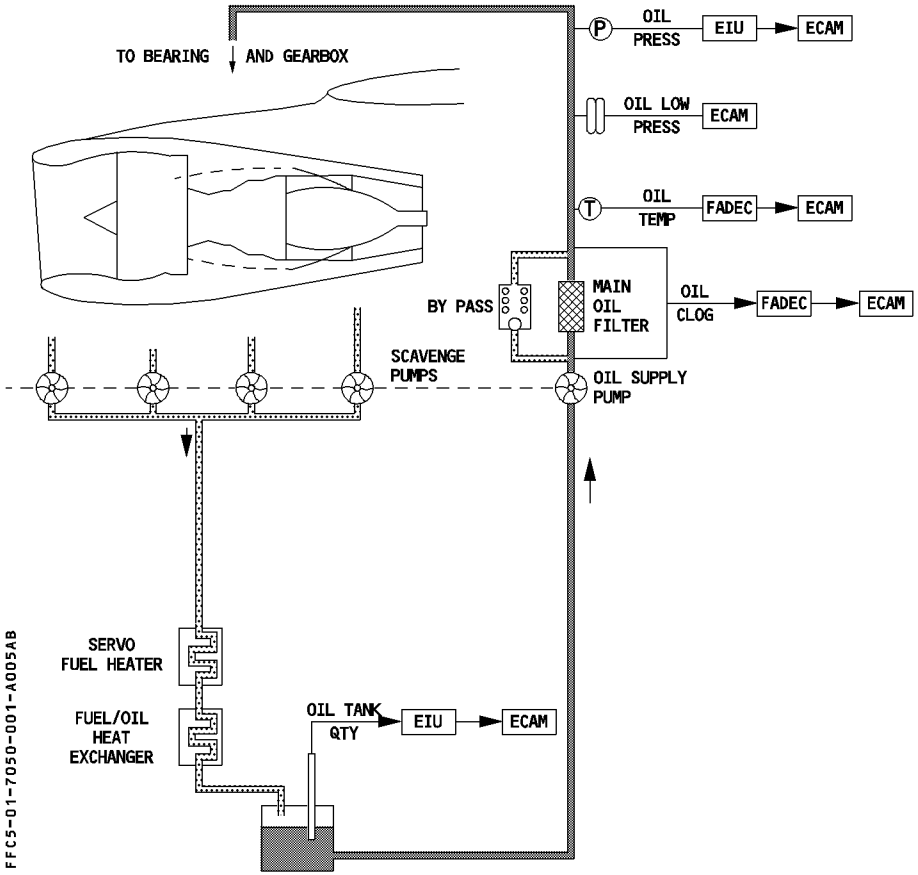
The recirculation to tank is inhibited (Fuel Return Valve (FRV) closed) in the following cases:

- Engine starting
- Engine shutdown (N2 below 50 %)
- When fuel flow is above 2700 kg per hour (take-off power)
- Upon fuel system request which occurs in the following conditions :
  - Inner tank temperature above 59,5°C or,
  - Engines feed by gravity or,
  - Inner tank quantity below 500 kg or,
  - Inner tank high level and vent tank sensors are wet and at least one X-feed valve on each wing is open.
    This closure signal is inhibited if all the following coonditions are met :
    - Fuel flow below 1000 kg per hour
    - Engine oil temperature above 115°C
    - Altitude above 15,000 ft.
- When fuel flow is above 1300 kg per hour in emergency electrical configuration.

GENERAL

The oil system lubricates the engine components.
It contains :
- the oil tank
- the lube and scavenge pump modules
- the fuel/oil heat exchangers
- the filter, pressure relief and bypass valves.

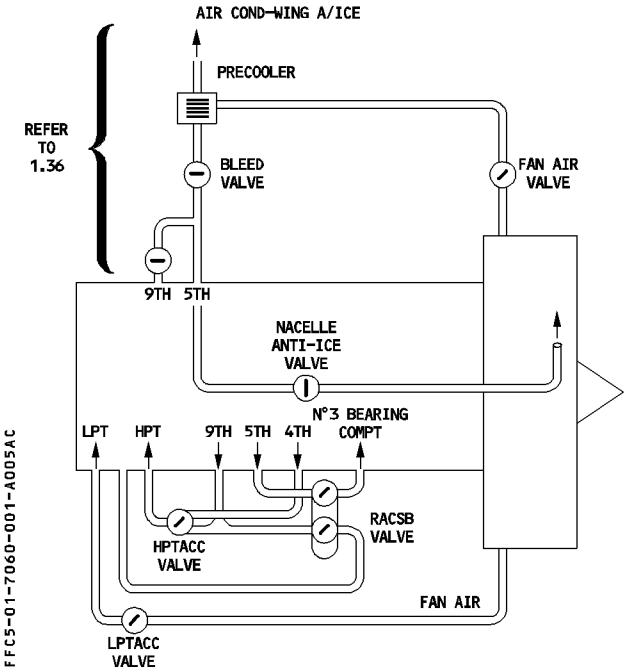
FOR INFO



GENERAL

The air bleed system is provided for various aircraft uses.
It is used for :

- pneumatic system (Refer to 1.36)
- cooling the engine compartment and the turbine



COOLING

ROTOR ACTIVE CLEARANCE CONTROL START BLEED SYSTEM

The rotor active clearance (RAC) and the start bleed (SB) control systems use air from 5th stage to control the clearance of the high pressure compressor rotor blades relative to the high pressure compressor stator case, and 9th stage to unload the compressor during starts and accelerations.
The function of the RAC system is to improve compressor efficiency during cruise, and the function to the SB system is to improve stall margin during engine start and acceleration.

HP TURBINE CLEARANCE CONTROL (HPTCC) SYSTEM

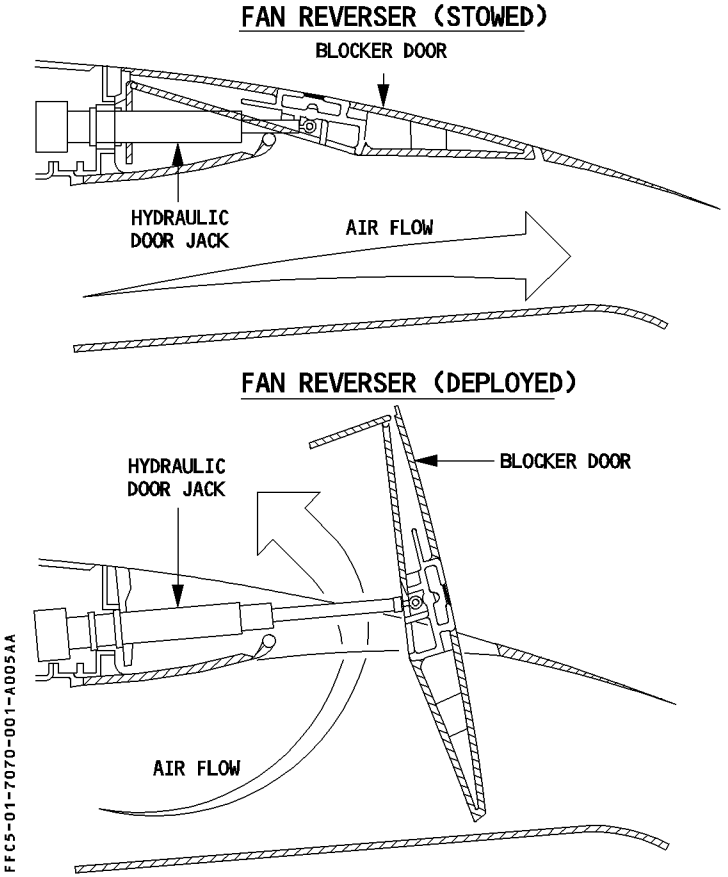
The HPTCC system is controlled by the FADEC through the HMU and controls the high pressure turbine clearance. The FADEC modulates the high pressure compressor bleed air flow for the high pressure turbine case cooling.
It provides optimization of high pressure turbine performance and EGT reduction.

LP TURBINE CLEARANCE CONTROL (LPTCC) SYSTEM

The LPTCC system is controlled by the FADEC through the HMU and controls low pressure turbine clearance.
The FADEC modulates the fan bleed air flow for the low pressure turbine case cooling.

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 and ENG 4.
- The blue circuit powers the doors on ENG 2.
- The yellow circuit powers the doors on ENG 3.

The thrust reverser system is independently controlled for each engine by the associated FADEC. It is controlled and monitored by each FADEC channel.
The thrust reverser system on each engine includes :
– 4 actuators
– 4 latches
– door position switches
– A shut off valve which allows the hydraulic pressure to the HCU.
– a Hydraulic Control Unit (HCU) which :
  · pressurizes the thrust reverser hydraulic system
  · regulates the blocker doors speed
  · supplies actuators with hydraulic power

Each pivoting door moves independently (no synchronization). The total actuation time is less than 2 seconds.

ACTUATION LOGIC

Deployment requires :
– one FADEC channel operating with its associated throttle reverse signal
– aircraft on ground from at least one LGCIU
– TLA reverse signal from PRIM 1 (FLT CTL PRIMARY COMPUTER 1) or associated PRIM
– switch reverse signal from associated EIU

Before the transit completion of the blocker doors, the FADEC sets reverse idle thrust.

ENG 1 AND 4 THRUST REVERSER LEVER INTERLOCK

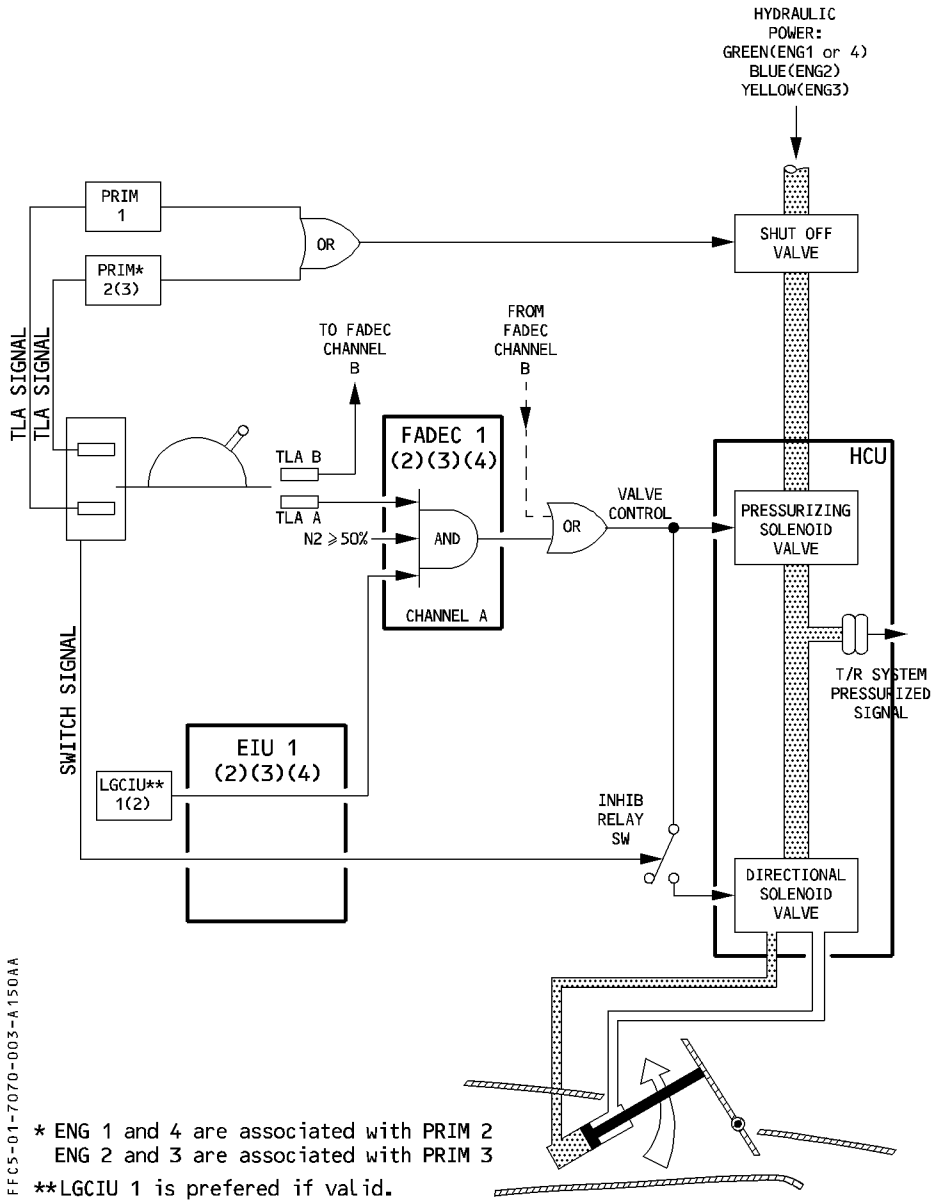
Thrust reverser lever interlock prevents the application of asymmetrical reverse thrust on the outboard engines.
For this purpose the thrust lever is limited at reverse idle until both EIU 1 and 4 have released the interlock, confirming that both thrust reversers are fully deployed.

IDLE PROTECTION

The FADEC will automatically select idle thrust if the reverse thrust is not selected and one of three following conditions occurs :
– 4 doors are unstowed or,
– at least one door is unstowed and the thrust reverser system is pressurized, or
– the thrust reverser position is not determined and the reverser system is pressurized.

SCHEMATIC

FOR INFO



* ENG 1 and 4 are associated with PRIM 2
ENG 2 and 3 are associated with PRIM 3

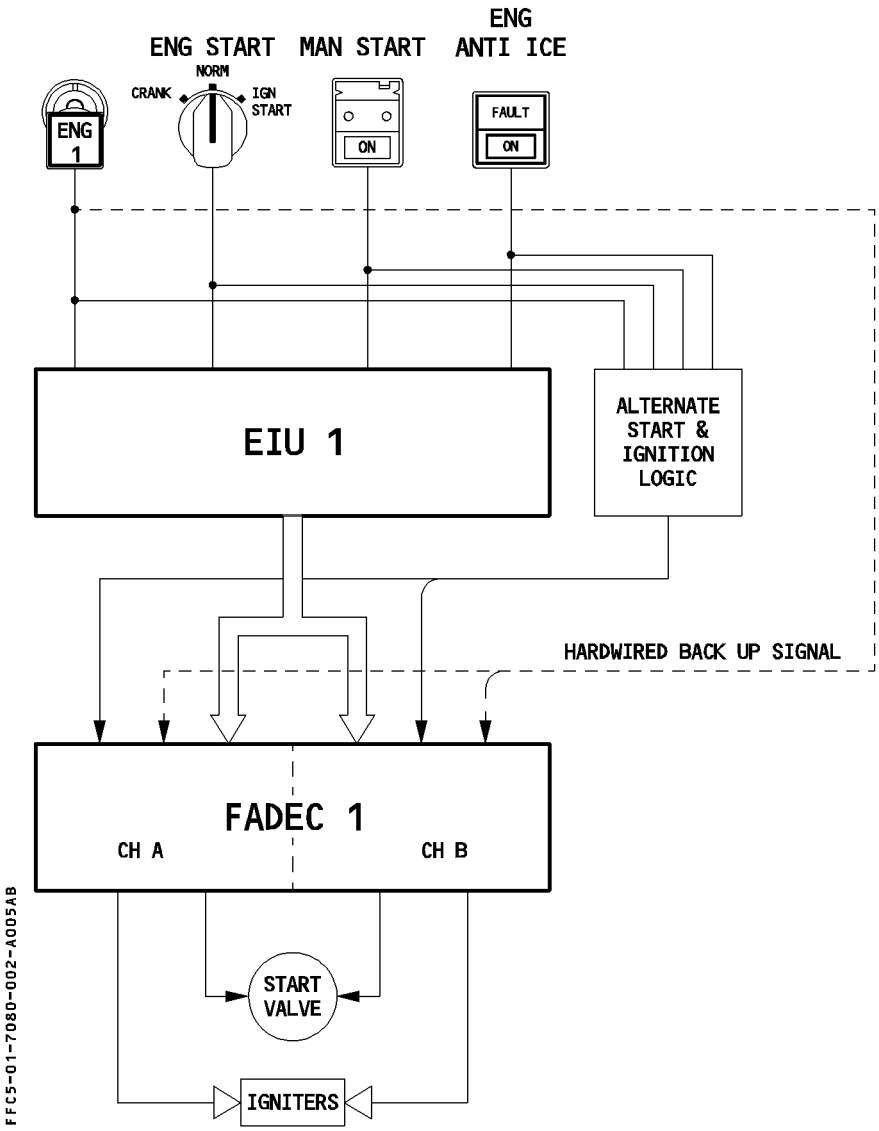
**LGCIU 1 is prefered if valid.

GENERAL

The ignition and starting system is controlled by the FADEC according to :
- engine start selector position
- engine master switch position
- ENG MAN START pushbutton position
- ENG ANTI ICE pushbutton position
- flight/ground aircraft condition.

In normal operation, the FADEC receives its inputs from the EIU.
In the event of EIU signal loss, all the functions, except man start and wet crank, will remain available by using both a back up signal from the engine master switch, and the alternate start/ignition signal.

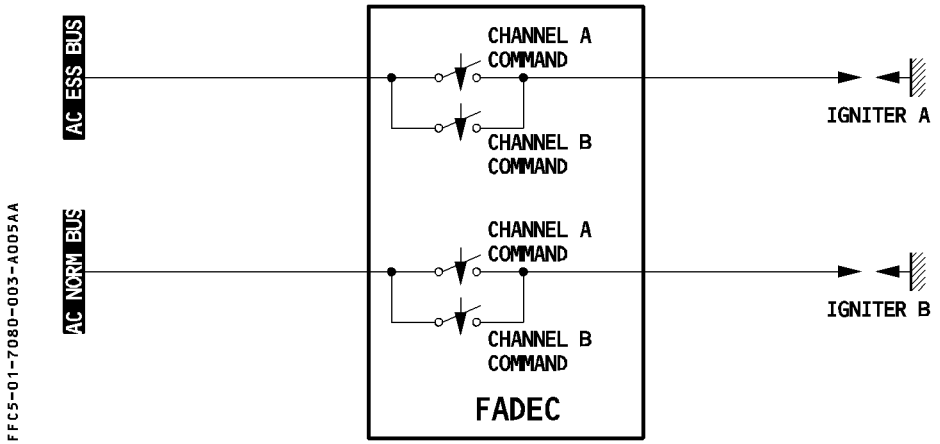
ARCHITECTURE



IGNITION SYSTEM

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

FOR INFO



IGNITION FOR STARTING

ON THE GROUND

During an automatic start only one igniter is supplied. The FADEC automatically alternates the use of igniters at each start.
The ignition is automatically selected when N2 reaches 16 %.
It is automatically cut off when N2 reaches 50 % N2.
During a manual start both igniters are supplied, when the engine master switch is at ON, it is automatically cut off when N2 reaches 50 % N2.

IN FLIGHT

Both igniters are supplied, when the engine master switch is at ON.

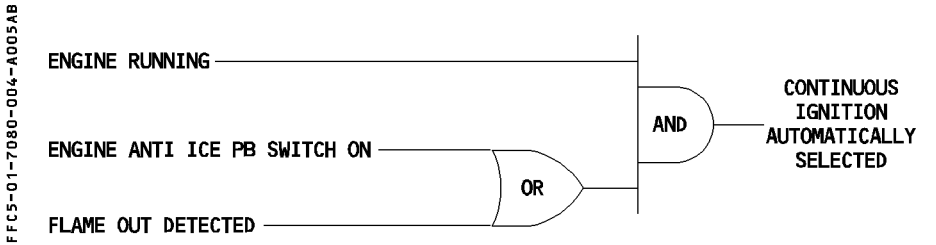
CONTINUOUS IGNITION

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

MANUAL SELECTION

In flight, continuous ignition is selected when the ENG START selector is on IGN/START provided the related engine is running.
On ground, after starting, since ignition is automatically cut off, it is necessary to cycle the ENG START selector to NORM, then back to IGN/START, to select the continuous ignition.

AUTOMATIC SELECTION



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. On the ground, in the event of electrical control failure the start valve can be manually operated by a handle.

AUTOMATIC STARTING

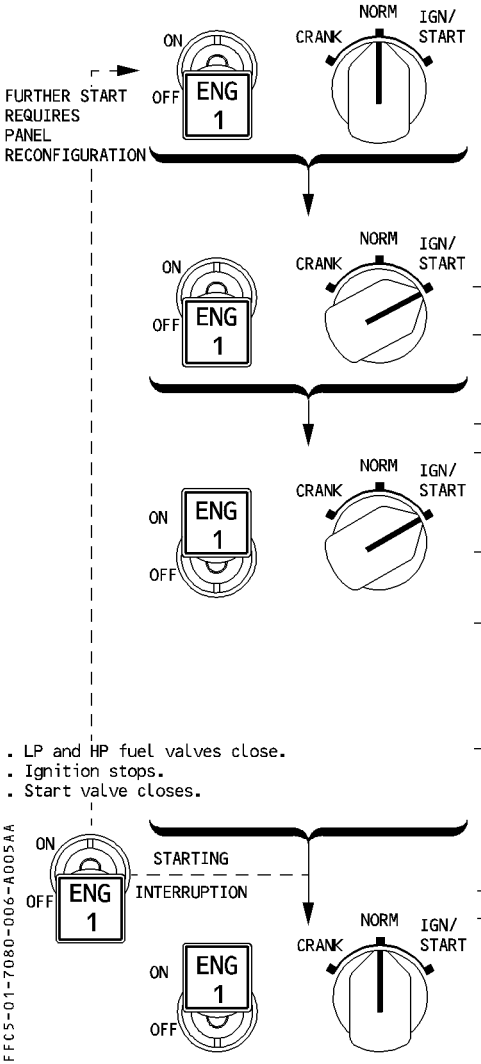
This sequence is under the full authority of the FADEC which controls :
– the start valve
– the igniter(s)
– the fuel HP valves.

It provides:
– detection of hot start, hung start, stall or no light up, and protection for starter reengagement speed and time.
– FAULT announcement with specific ECAM message.
– Start abort on ground (high pressure valve closure, start valve closure, ignition stopped) and automatic engine crank after start abort and control of any additional start attempts.

In flight, the FADEC will select a starter assisted airstart if N2 is below 16 %.
This sequence may be interrupted by selecting the engine master switch to OFF.

AUTOMATIC STARTING SEQUENCE

R



R *Note : (*) If after 30 seconds the engine master switch is not ON, the pack valves will*
R *reopen.*
(**) At first engine start, if after IGN/START selection no further action is applied, the ECAM ENG page will automatically disappear after 30 seconds.
(***) If ENG START selector is not switched to NORM, the ENG page is automatically replaced by the WHEEL page 15 seconds after 4th engine start.

MANUAL STARTING

Manual starting is under limited authority by the FADEC which controls :
- start valve opening when the ENG START selector is set to IGN/START and the MAN START pushbutton sw is depressed
- high pressure fuel valve and operation of both igniters when the engine master switch is set to ON.
- start valve closure at 50 % N2, and, on ground, ignition cut off.

The FADEC provides a passive survey of the engine during the starting sequence.
On the ground, it will automatically abort the starting sequence in case of starting EGT limit exceedance or starter reengagement speed exceedance.
The sequence may be interrupted :
- before engine master switch set to ON by selecting MAN START pushbutton to off.
- after engine master switch set to ON by selecting it back to OFF. In this case a dry crank shall be selected by the crew.

Note : When the engine master switch is set to on, selecting the MAN START pushbutton to off has no effect.

In flight, the FADEC always commands a starter assisted airstart.

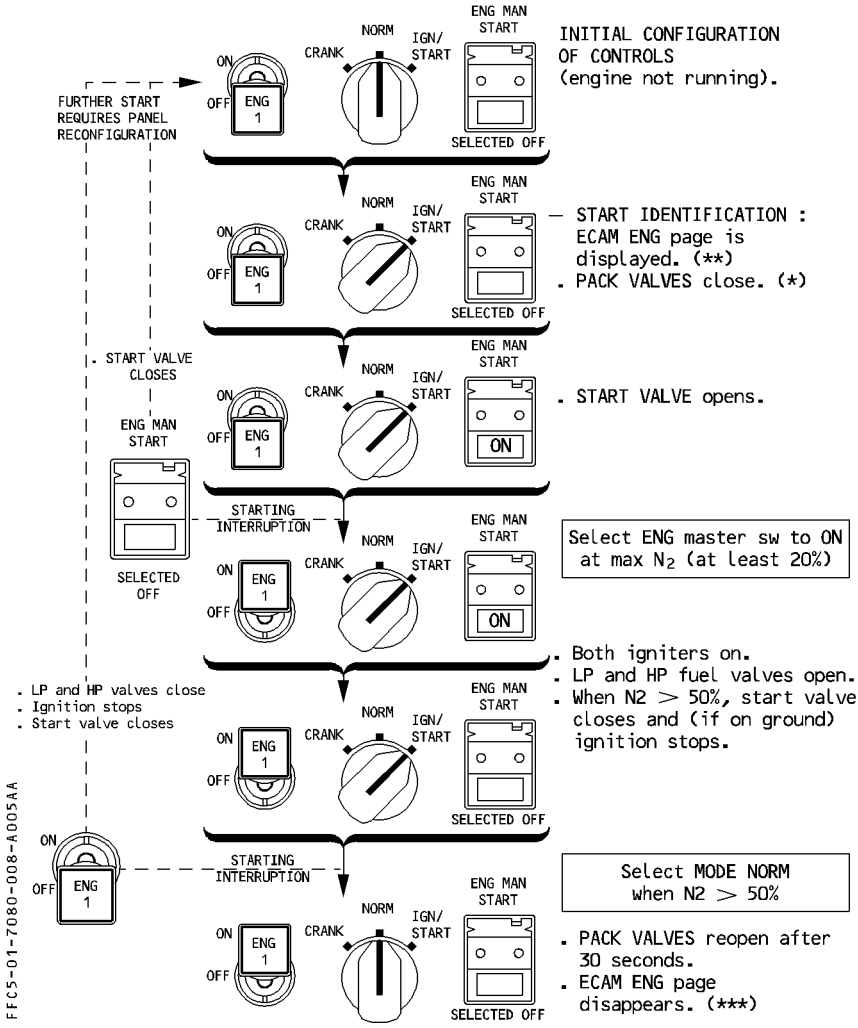
ENGINE VENTILATION (Dry cranking)

A dry cranking cycle enables the engine to be ventilated to remove fuel vapors after an unsuccessfull start attempt on the ground.
Cranking can be manually selected by setting the ENG START selector to CRANK and the MAN START pushbutton to ON (engine master switch OFF). It is stopped by setting the MAN START pushbutton to off. APU speed (if used) increases during the dry cranking cycle.

CAUTION
Selecting the ENG START selector to NORM would not stop the cranking.

MANUAL STARTING SEQUENCE

R



R *Note : (*) If, after 30 seconds the ENG MAN START pushbutton is not switched ON, the*
R *pack valves will reopen.*
(**) At first engine start, if after IGN/START selection no further action is applied, the ECAM ENG page will automatically disappear after 30 seconds.
(***) If ENG START selector is not switched to NORM, the ENG page is automatically replaced by the WHEEL page 15 seconds after 4th engine start.

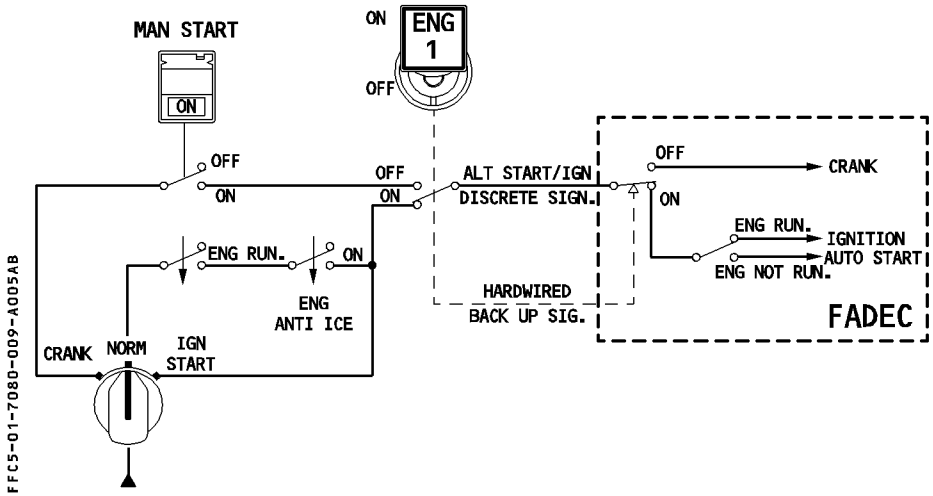
ALTERNATE START / IGNITION INFORMATION

In case of EIU failure, the FADEC uses a backup signal from the engine master switch and the alternate start/ignition signal to control :

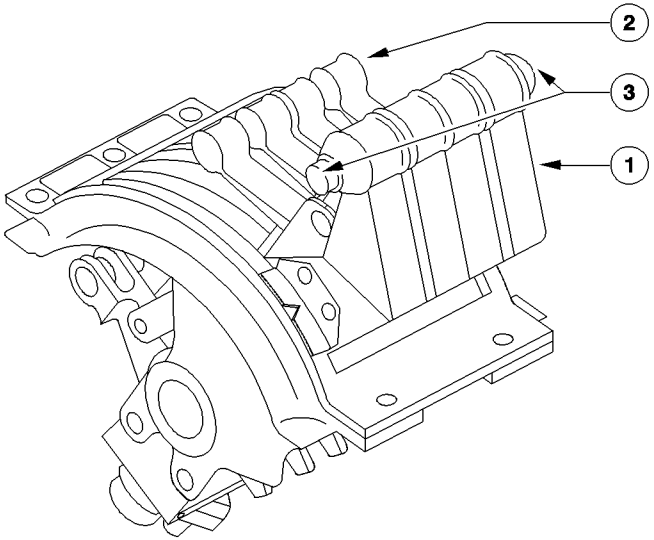
– an automatic starting,
– a dry crank or
– the continuous ignition

Manual starting is no longer available.

FOR INFO



PEDESTAL



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(1) Thrust levers

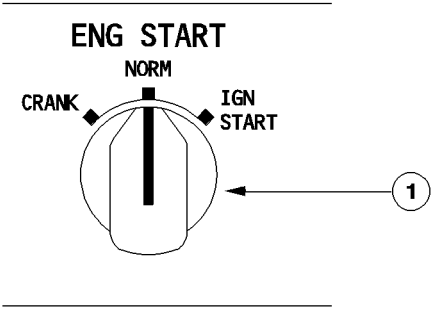
(Refer to 1.70.30)

(2) Reverse control levers

When the thrust levers are not at idle, the reverse control levers are mechanically locked in the stowed position.
When the thrust levers are at idle, thrust reverser operation can be controlled by pulling backward the reverse control levers.
A detent indicates to the crew the reverse idle position. For engines 1 and 4, this position cannot be exceeded until complete deployement of the reversers of the two engines.
For reverse thrust application the reverse control levers are pulled rearward as required.
For stowage of reversers the levers are moved forward then pushed down.

(3) Autothrust instinctive disconnect pb

(Refer to 1.22)



FFC5-01-7090-002-A005AA

(1) ENG START selector

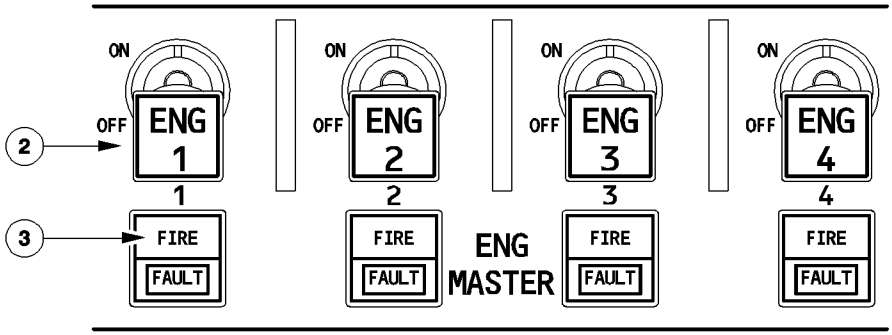
CRANK : The start valve opens, provided the MAN START pushbutton is ON.
R Ignition is not supplied. Both pack flow control valves close when
R CRANK is selected, provided the MAN START pushbutton is ON.

NORM : Continuous ignition A + B is selected, when the engine is running, and one of the following conditions is met :
- The ENG ANTI ICE pushbutton is ON, or
- A Flame-out is detected.

IGN START : - If the engine master switch is ON and N2 ≥ idle, continous ignition is selected.
- During an automatic start, the ignition will be selected :
  · On ground, when N2 ≥ 16 %
  · In flight, at start sequence initiation.
- During a manual start, the ignition is selected when the engine master switch is selected ON.

R Both pack flow control valves automatically close during the start sequence (Refer to 1.21.20). APU speed (if used) increases.

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



(2) ENG MASTER sw 1 (2) (3) (4)

ON : Low pressure fuel valve will open (provided the ENG FIRE pushbutton is in).
- During an automatic start, the high pressure fuel valve opens provided :
  - the ENG START selector is at IGN / START
  - the N2 is above the following threshold :
    - on ground : 22 %
    - in flight : 12 % below 20000 ft, 16 % above 20000 ft.
- During a manual start, the high pressure fuel valve will open provided :
  - ENG START selector is at IGN / START
  - MAN START pushbutton is ON

OFF : A Closure signal is sent directly to the high pressure fuel valve and the low pressure fuel valve.
Controls the reset of both channels of the FADEC.

Note : Releasing ENG FIRE pushbutton permits engine shutdown by closing the LP fuel valve. There is a time delay of about 40 seconds at ground idle (the time delay is due to fuel left between low pressure valve and nozzles)

(3) FIRE FAULT lt 1 (2) (3) (4)

FAULT lt : Illuminates amber associated with ECAM caution in case of:
- an automatic start abort
- a disagreement between the high pressure fuel valve position and its commanded position.

OVERHEAD PANEL

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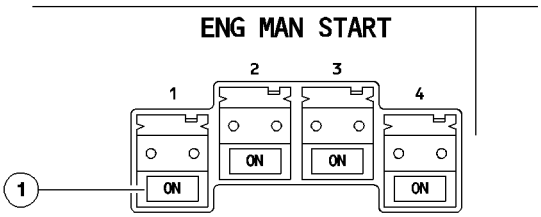

(1) ENG MAN START pushbutton

ON : The start valve opens, provided the ENG START selector is set to CRANK or IGN/START.
Both pack valves close during the start sequence.

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

The ON light comes on blue.

Off : When the ENG MAN START pushbutton is set off during a manual engine start, the start valve closes, provided the engine master switch is in the OFF position.

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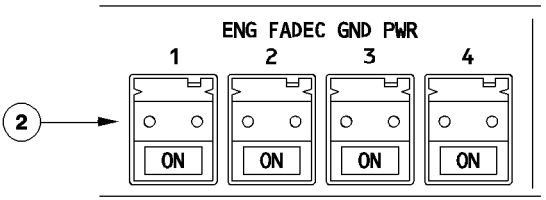


(2) ENG FADEC GND PWR pushbutton

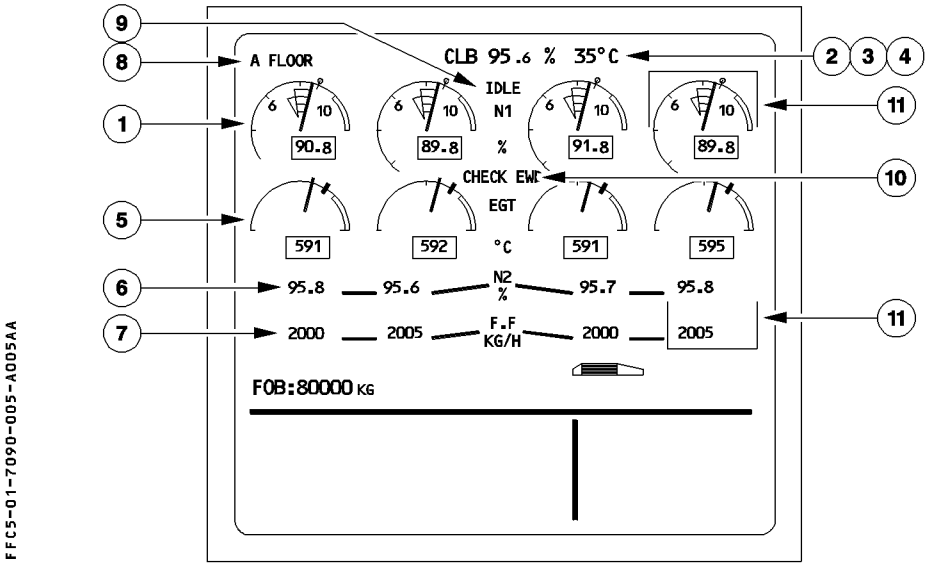
R ON : The FADEC is supplied by the aircraft network for 15 minutes (unless the ENG FIRE pushbutton is released out, or the FADEC Generator is available). The "ON" light comes on with a delay of 2 seconds.

ECAM

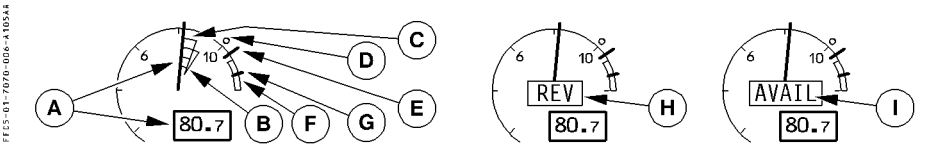
GENERAL

The engine primary parameters are permanently displayed on the upper ECAM.
The secondary parameters are displayed on the lower ECAM SD when selected automatically or manually.
In case of all DMC ECAM channel failure the engine primary parameters can be displayed on each ND using the ND selector on the EFIS control panel.

PRIMARY PARAMETER



(1) LP rotor speed (N1)



(A) Actual N1

The N1 needle and N1 digital indication are :

- normally green
- amber when the actual N1 is above the N1 MAX (see E)
- red when the actual N1 is above the N1 RED line (104.2 %).

When N1 is degraded (in case both N1 sensors fail), the last digit of the digital display is amber dashed.

(B) N1 Command (N1 tendency)

The green needle corresponds to N1 demanded by the FADEC. In addition next to the N1 trend needle a green triangle indicates the direction of N1 tendency. These symbols are displayed only when A/THR is active.

(C) Transient N1

Symbolizes the difference between the N1 command and the actual N1. It is displayed only when A/THR is active.

(D) N1TLA (blue circle)

N1 corresponding to the thrust lever position (predicted N1)

(E) N1 MAX

Amber index at the value corresponding to the N1 limit value of the TOGA or REV mode.

(F) Max permissible N1

N1 redline is represented by a red arc at the end of the scale beginning at 104.2 %

(G) N1 exceedance

If 104.2 % is exceeded, a red mark appears and remains at the maximun value achieved. It will disappear after a new start on ground or after maintenance action through the MCDU.

(H) REV indication

The REV indication appears in amber when one reverser is unstowed or unlocked. It changes to green when the doors are fully deployed and reverse mode is selected. (If unlocked in flight the indication first flashes for 9 seconds and then remains steady).

(1) AVAIL indication

Displayed in green to indicate a successful engine start on ground.
It pulses in green to indicate a successful engine relight in flight.
It is triggered when the engine is at, or above, idle.

(2) Thrust limit mode

TOGA, FLX, CLB, MCT, limit mode, selected by the thrust lever, is displayed in blue.
If a derated takeoff has been selected by the crew, D04, D08, D12, D16, D20, or D24 will be displayed.
DCLB1 or DCLB2 is displayed during the climb phase, if the crew has selected a derated climb via the MCDU PERF CLB page.

(3) N1 rating limit

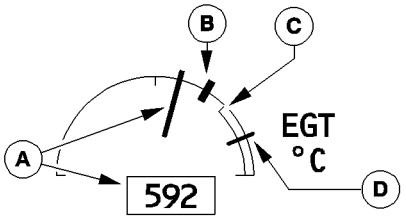
Computed by the FADEC, according to the thrust lever angle, and is displayed in green.

Note : – *The highest thrust limit mode of the four engines, and its associated N1 limit value, is displayed.*
– *On ground, with the engines running, the displayed N1 rating limit corresponds to the TOGA thrust limit, whatever the thrust lever position may be.*
On ground, with the engines running and if FLEX mode is selected, FLEX N1 is displayed, whatever the thrust lever position may be, between IDLE and FLX / MCT.
On ground, with the engines running and if DERATED mode is selected, DERATED N1 is displayed, whatever the thrust lever position may be, between IDLE and FLX/MCT.

(4) FLEX temperature

If a FLEX temperature has been entered via the MCDU and validated by the FADEC, this temperature is displayed in blue.

(5) EGT indicator



FFCS-01-7090-008-A005AA

(A) Actual EGT
- Normally green
- Becomes amber above 915°C (or above 725°C during start sequence) except for high power operation (FLEX takeoff or thrust lever above MCT or at maximum REV, or activation of alpha–floor).
- Becomes red above 950°C.

(B) EGT Max (amber)
725°C at engine start then 915°C.

(C) Max permissible EGT
EGT red line is at 950°C. A red arc is displayed above 950°C to the end of the scale.

(D) EGT exceedance
If 950°C is exceeded, a red mark appears at the max value achieved. It will disappear after a new start on the ground or after a maintenance action through the MCDU.

(6) HP rotor speed N2

Digital indication normally green is over brightning during engine start and located in a grey background box.
When the N2 is above 105 % the indication becomes red and a red cross appears next to the digital indication. The red cross will disappear only after a new start on ground or after a maintenance action through the MCDU.
When the N2 value is degraded (in case of a dual N2 sensor failure), the last digit is amber dashed.

(7) Fuel flow

Green indication

(8) A FLOOR message

Is displayed amber when the ECUs receive the corresponding signal from FMGS.

(9) IDLE message

IDLE is displayed in green when running engines operate at minimum power. First pulses for 10 seconds then remains steady.

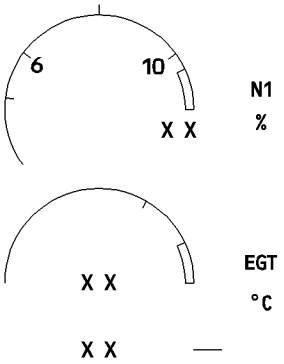
(10) CHECK EWD message

Is displayed amber on the EWD and on both ND in case of discrepancy between N1, N2, EGT, FF values on FADEC DMC bus and corresponding displayed information.

(11) White box

Displayed around a parameter when an engine needs specific monitoring i.e. :
- Red or amber line exceedance of any parameter
- Engine starting sequence
- Engine stopped (in flight).
- Reverser unstowed in flight or on ground out of REV mode.

Note : In case of invalidity of any parameter, the associated digital indication is replaced by two amber crosses. For N1 and EGT parameters, the needle and the box around the digital display are removed.



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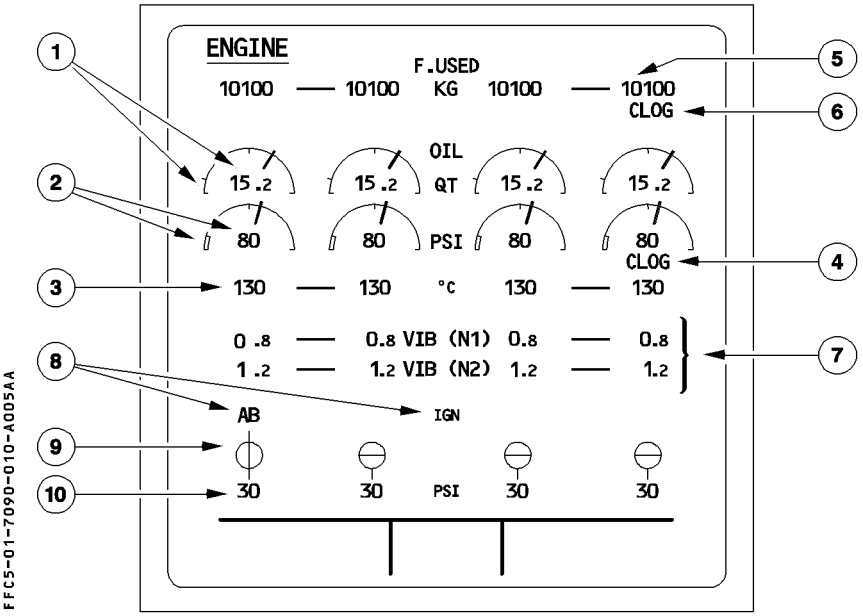
SECONDARY PARAMETERS

START CONFIGURATION



(1) Oil quantity indication

The needle and the digital indication are normally green.
The digital indication pulses if the oil quantity drops below 1.8 quarts.
(Also displayed on ECAM CRUISE page).
Advisory is inhibited :
– at TO (FLEX or derated) or go around
– when reversers are selected
– in alpha floor mode

(2) Oil pressure indication

The needle and the digital indication are normally green.
The digital indication pulses if oil pressure exceeds 90 psi.
The needle and the digital indication are red if the oil pressure drops below 13 psi.

(3) Oil temperature indication

Normally green
The indication pulses above 140° C
The indication becomes amber if temperature exceeds :
– 140° C for more than 15 minutes
– or, 155° C without delay.

(4) Oil filter clog indication

R CLOG message appears in amber in case of excessive pressure loss accross the main oil filter.

Note : This is not an indication that the bypass valve is open.

(5) Fuel used indication

The fuel used value computed by the FADEC is normally displayed in green.
After a transmission interruption by the FADEC, if the displayed value is 100 kg less than the actual value it is crossed by 2 amber dashes.
It is reset at engine start, on ground.
Also displayed on ECAM CRUISE page.

(6) Fuel filter clog indication

CLOG message appears in amber in case of excessive pressure loss accross the fuel filter.

(7) VIB indications

The indication is green.
It pulses above 5.7 units for N1 and 5.6 units for N2.
Also displayed on ECAM CRUISE page.

(8) Ignition indication

IGN is displayed in white during the start sequence.
The selected ignitors "A" or "B" or "AB" are displayed in green when supplied.

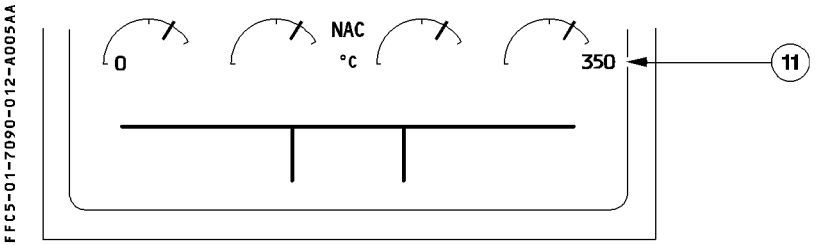
(9) Start valve position indication

⏀ green : valve fully open
⊖ green : valve fully closed.
⏀ amber : valve abnormally fully open
⊖ amber : valve abnormally fully closed

(10) Engine bleed pressure

Bleed pressure upstream of the precooler is normally displayed in green.
It becomes amber below 21 psi with N2 ≥ 10 % or in case of overpressure.

AFTER START CONFIGURATION

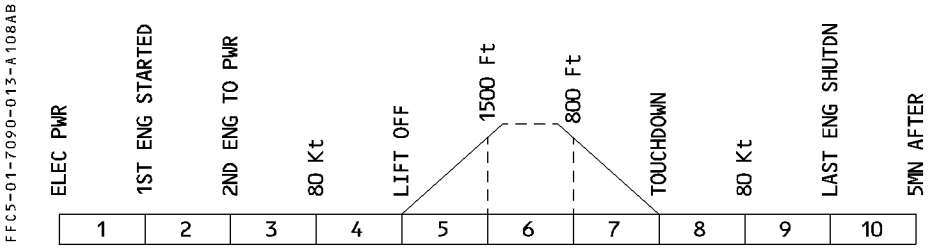


(11) Nacelle temperature indication

Nacelle temperature needles are displayed. Becomes pulsing if the temperature exceeds 240°C.
The advisory threshold is indicated by a small mark on the arc.
NAC is displayed in white.
All nacelle temperature indications are removed during engine start.

Note : In case of invalidity of any parameter, the associated digital indication is replaced by two amber crosses.
For OIL QTY, OIL PR and NAC TEMP the needle is removed.

WARNINGS AND CAUTIONS



R

E / WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
ALL ENG FLAME OUT Total engine flame out	CRC	MASTER WARN	NIL	NIL	NIL
N1 OVERLIMIT N1 above 104.2 %					4, 8
N2 OVERLIMIT N2 above 105 %					
EGT OVERLIMIT EGT above 915°C (950° at TO power)	SINGLE CHIME	MASTER CAUT			
OIL LO PR Oil pressure low	CRC	MASTER WARN	ENG		1, 10
MINOR FAULT Engine short time limited dispatch	NIL	NIL	NIL		
CTL SYS FAULT VBV or VSV failure or loss of parameters (PS 3, T25, T3, N1, N2) or loss of FMV, VSV position or burn staging valve failure or RAC system failure.	SINGLE CHIME	MASTER CAUT			4, 5, 7, 8
BLEED STATUS FAULT Bleed status not received by active FADEC channel					3, 4, 5, 7, 8
ENG FAIL eng core speed below idle with master sw ON and fire pb is not pushed					NIL
ENG SHUT DOWN eng master at OFF in phases 3 to 8 or eng fire pb pushed in phases 1, 2, 9 and 10					
THR LEVERS NOT SET Throttle set between MCLB and MCT at TO Flex or derated takeoff mode not selected by at least one FADEC					1 4 to 8 10
ENG T.O. THRUST DISAGREE One FADEC at least selects a different thrust takeoff mode on ground					1 4 to 10
ENG STALL Stall detected (not during start sequence)			ENG		3, 4, 5, 7, 8

R

E / WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
EIU FAULT Data bus between EIU and FADEC failed. Engine vib indication is lost.	SINGLE CHIME	MASTER CAUT	NIL	NIL	3, 4, 5, 8
FADEC SYS FAULT One NOGO failure affects one or both channels channel failure or alternate fault or overspeed governor fault or sensor failure		NIL			4, 5, 6, 7, 8
FADEC FAULT Data bus between FADEC and ECAM failed.		MASTER CAUT	ENG		4, 5, 7, 8
FADEC OVHT					
FUEL FILTER CLOG	NIL	NIL			
IGN A+ B FAULT Both ignition circuits are failed.	SINGLE CHIME	MASTER CAUT	NIL		3, 4, 5, 7, 8
IGN A(B) FAULT Ignition circuit A or B is failed.	NIL	NIL			
TYPE DISAGREE Disagree between pin programming on the FADEC and on the FWC (engine rate).	SINGLE CHIME	MASTER CAUT			3 to 10
REV FAULT Loss of thrust reverser on one engine					3, 4, 5
REV ISOL FAULT					3 to 8
REV PRESSURIZED Reverser system is pressurized, while rev doors are stowed and locked with no deploy order (on ground).					1, 8,
REV UNLOCKED One reverser door not locked in stowed position with no deploy order.					8
REV INHIBITED Reverser is inhibited by maintenance action.	NIL	NIL			3 to 8
THR LEVER FAULT Both resolvers on one thrust lever failed.	SINGLE CHIME	MASTER CAUT			8
THR LEVER DISAGREE Disagree between both resolvers of a thrust lever.					4, 5, 8
OIL LO TEMP Engine oil temp < -10°C (on ground before takeoff).			ENG		3 to 9
OIL HI TEMP Engine oil temp between 140°C and 155°C for more than 15 minutes, or above 155°C.					4, 5, 7, 8
OIL FILTER CLOG It can be triggered only when N1 is less than 75% and altitude is below 20 000 feet.			NIL		3, 4, 5, 7, 8
THRUST LOCKED The thrust is frozen on one or more engine after an unvoluntary A/THR disconnection. This caution is recalled every 5 seconds, until thrust levers are moved.					2, 3, 4, 8, 9

R

E / WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
START VALVE FAULT The start valve is either stuck closed or stuck open or no starter air pressure is available (valve disagree)	SINGLE CHIME	MASTER CAUT	ENG	Associated FAULT lt on ENG panel on pedestal (except in case of starter time exceeded)	3, 4, 5, 7, 8
START FAULT Start fault due to : . starter time exceeded or . stall or . EGT overlimit or . no light up or . low N1 or . starter failure or . hung start or . high tailwind start or . THR levers not at idle.					
HP FUEL VALVE Fuel valve failed closed or open					
FUEL RETURN VALVE valve failed closed or open	NIL	NIL	NIL	NIL	
ENG THRUST LOSS In case of bleed problem during takeoff	SINGLE CHIME	MASTER CAUT	ENG		1, 4 to 10

MEMO DISPLAY

– IGNITION message is displayed in green when selected either automatically by the FADEC or manually by the crew.

BUS EQUIPMENT LIST

FOR INFO

			NORM			EMER ELEC		
			AC	DC	DC BAT	AC ESS	DC ESS	HOT
FADEC	CHANNEL A	ALL ENGINES				X		
	CHANNEL B	ENG 1 and ENG 3 ENG 2 and ENG 4	AC2-3 AC2-4					
EIU (ALL ENGINES)					X			
HP VALVES							X	
OIL PRESS		ENG 1 and ENG 3		DC2				
		ENG 2 and ENG 4		DC1				
IGNITION	A	All ENG				X		
	B	ENG 1 and ENG 3 ENG 2 and ENG 4	AC2-3 AC1-2					
REVERSERS DIRECTIONAL SOLENOID VALVE	A	All ENG		DC1				
	B	All ENG		DC2				
REVERSER SHUT OFF VALVE	ENG 1		AC2-4	DC2(1)				
	ENG 2		AC1-2				X	X(2)
	ENG 3		AC2-3	DC2				
	ENG 4		AC1-1				X	X(2)

(1) DC1 supplies if DC2 fails.
(2) HOT BUS supplies if DC ESS BUS fails.