Single Aisle
TECHNICAL TRAINING MANUAL
T2 (IAE V2500) (Lvl 2&3)
POWER PLANT IAE V2500

This document must be used for training purposes only

Under no circumstances should this document be used as a reference

It will not be updated.

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POWER PLANT IAE V2500

GENERAL

FADEC

IGNITION AND STARTING

ENGINE CONTROLS

ENGINE INDICATING

UGB13131 - U64T2M0

POWERPLANT SYSTEM COMPONENT LOCATION (2)

SYSTEM OVERVIEW

The IAE V2500-A5 engine is a two-spool, axial-flow, high-bypass-ratio turbo-fan power engine. The V2500-A5 can power all aircraft types of the Single Aisle family except the A318. V2500-A5 engines are available in several thrust ratings.
All the engines have the same basic configuration. A programming plug on the Electronic Engine Control (EEC) changes the available thrust.
The power plant installation includes the engine, the engine inlet, the exhaust, the fan cowls and the reverser assemblies. The pylon connects the engine to the wing structure. The engine is attached to the pylon by FWD and AFT mounts.

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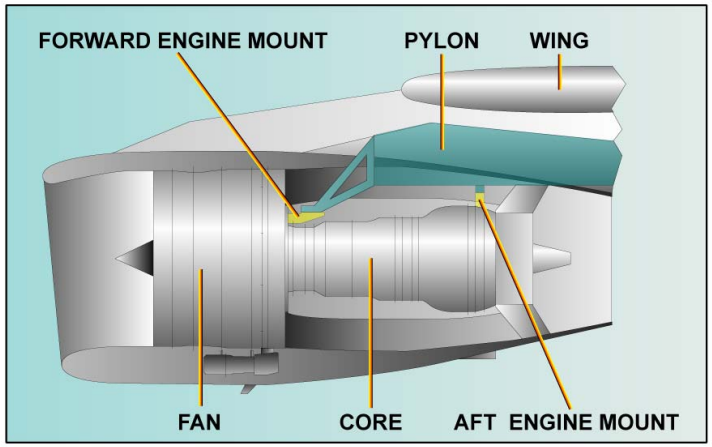
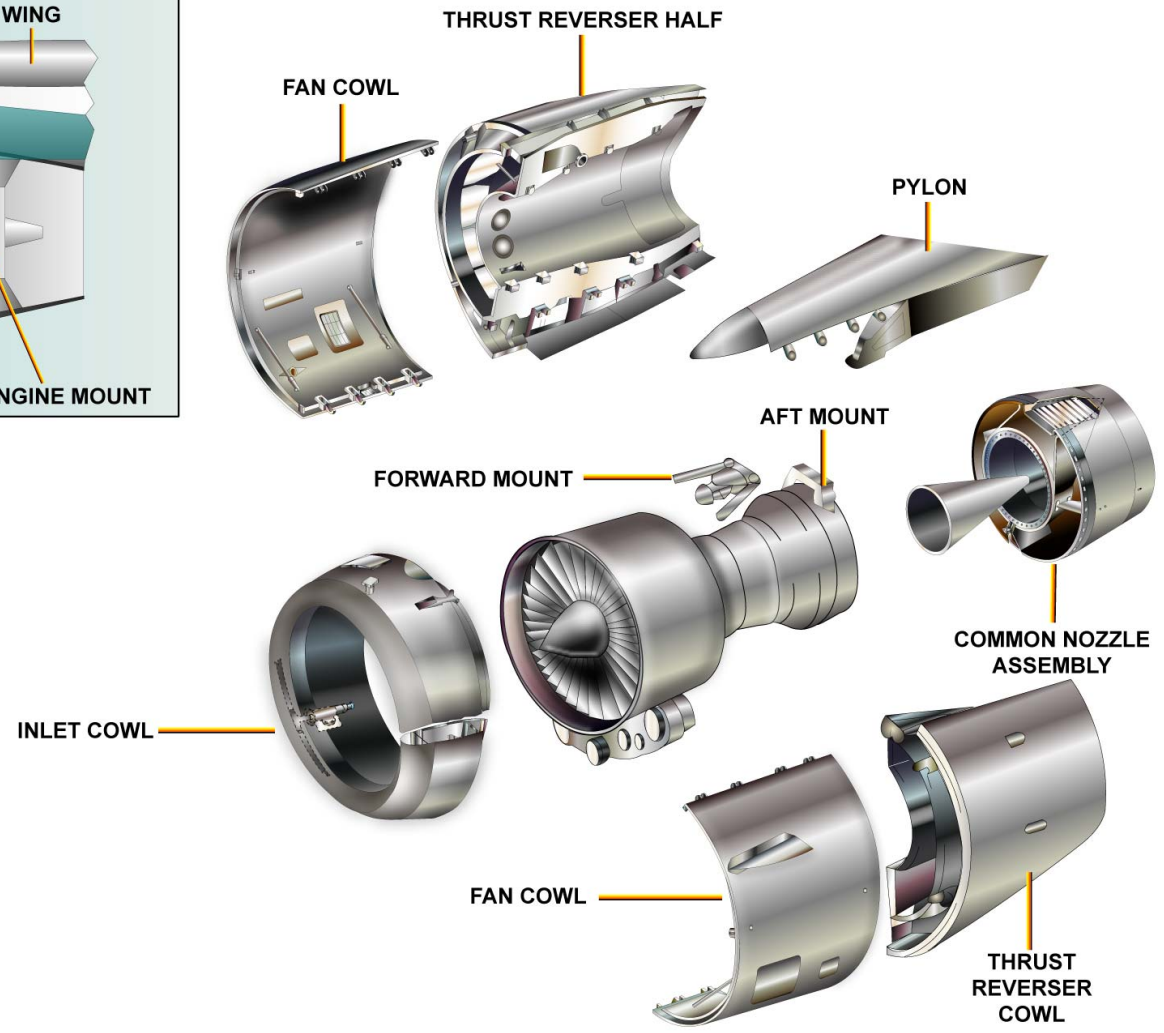




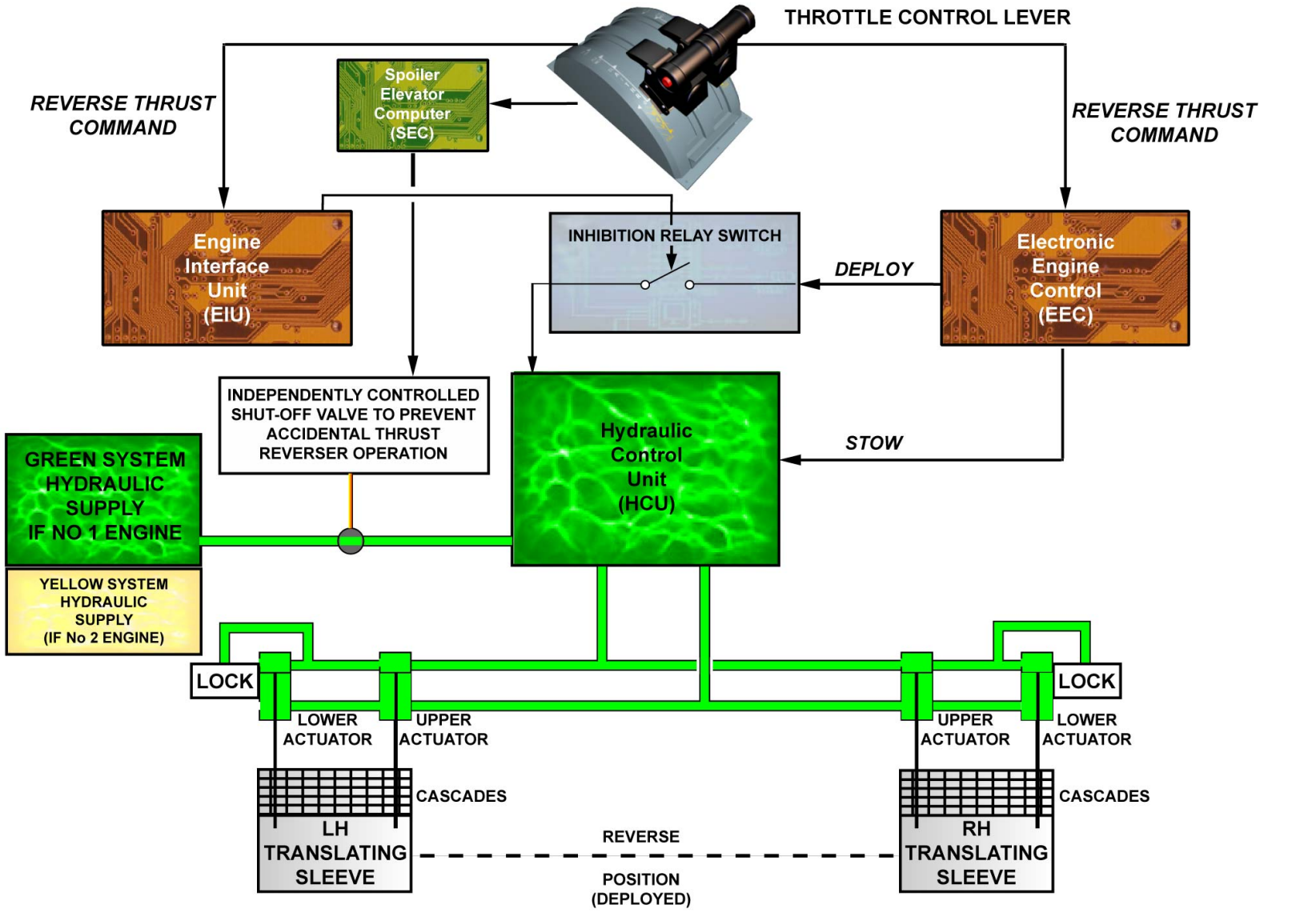
SYSTEM OVERVIEW

POWERPLANT SYSTEM COMPONENT LOCATION (2)

SYSTEM OVERVIEW (continued)

THRUST REVERSER SYSTEM

Reverse thrust is controlled by the EEC. A manual selection of the reverse is done when the flight crew lifts the latching levers on the throttle control levers. The reverse thrust command is sent to the EEC and the EIU. The DEPLOY command from the EEC goes through the INHIBITION RELAY (controlled by the EIU) as a second level of protection against accidental deployment.
In relation to commands from the EEC and the EIU, a Hydraulic Control Unit (HCU) supplies hydraulic power to operate the thrust reverser. The thrust reverser assembly has 2 hydraulically operated translating sleeves. The translating sleeves are each energized by 2 actuators. When the translating sleeve moves aft during deployment, it lifts blocker doors that redirect the engine fan airflow.



SYSTEM OVERVIEW - THRUST REVERSER SYSTEM

THRUST REVERSERS STOWED
-TRANSLATING SLEEVE CLOSED-

THRUST REVERSERS DEPLOYED
-TRANSLATING SLEEVE OPEN-

SYSTEM OVERVIEW - THRUST REVERSER SYSTEM

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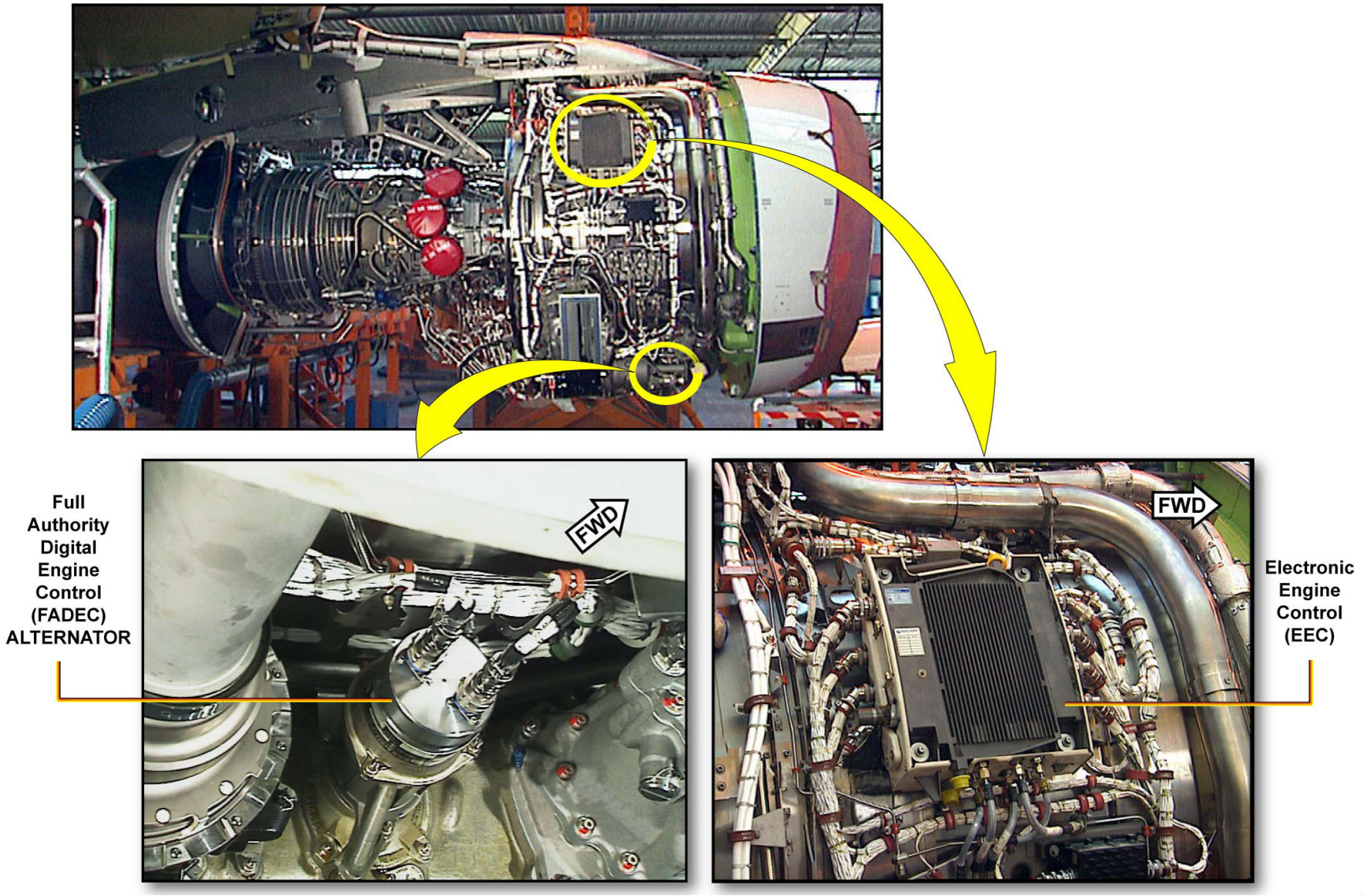
POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION

The engine system components are at the following locations.

FADEC

The EEC is on the RH side of the fan case. The FADEC alternator is on the gearbox.



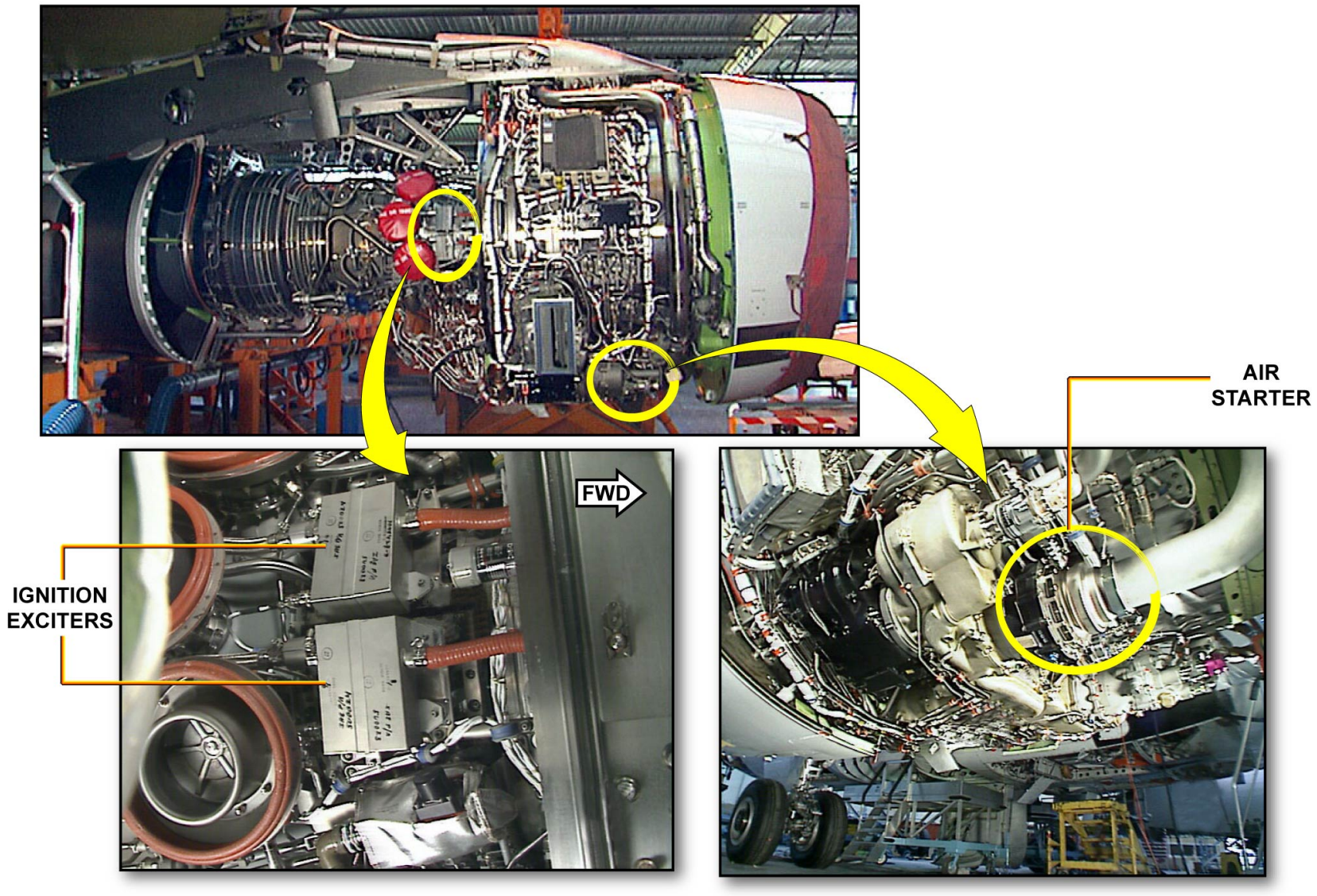
COMPONENT LOCATION - FADEC

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

STARTING

Two ignition boxes are on the RH side of the engine core. The air starter is on the RH side of the gearbox front face.



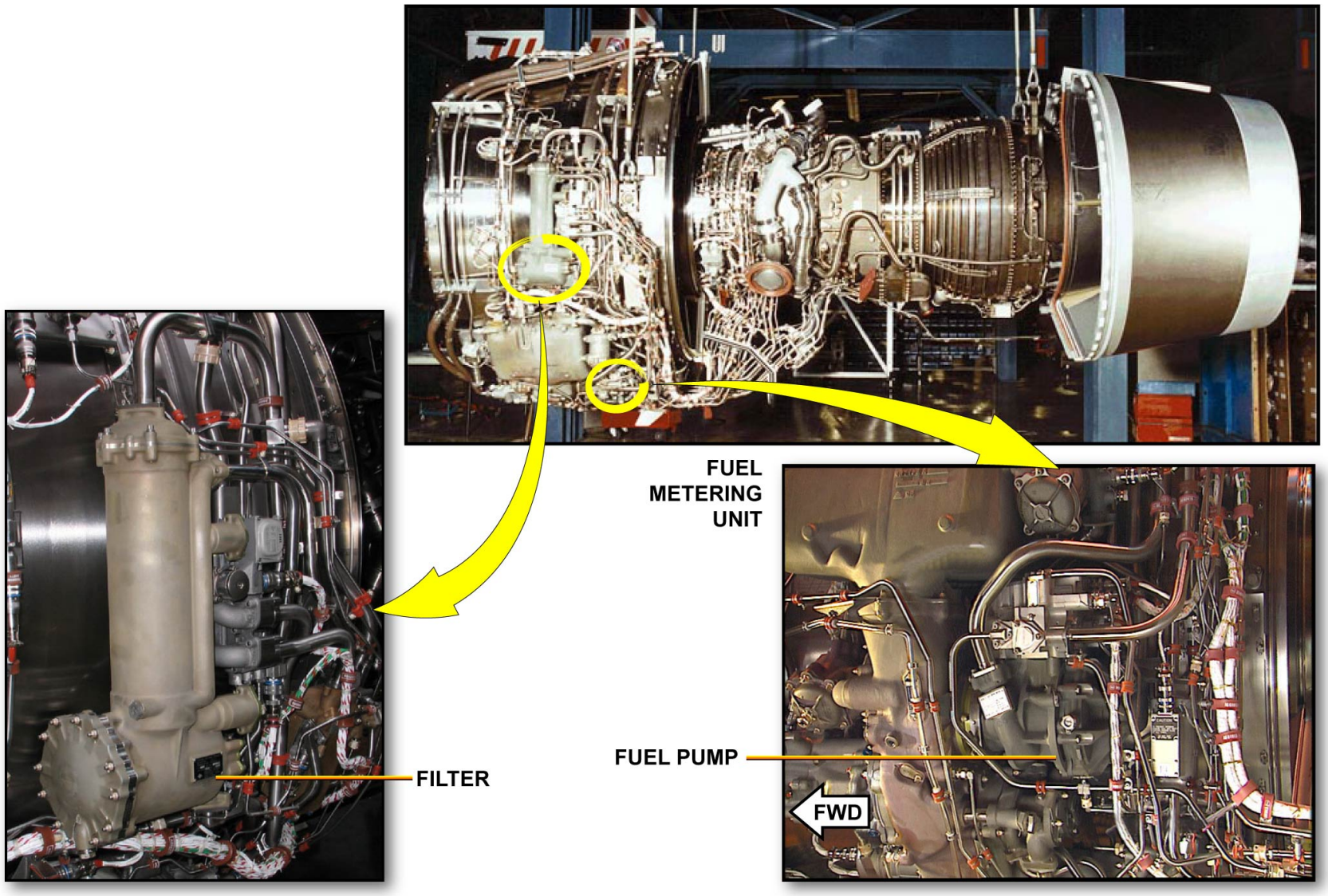
COMPONENT LOCATION - STARTING

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

FUEL

The primary components of the fuel system are on the LH side of the engine.
The fuel pump and the FMU are on the gearbox. The filter is on the LH side of the fan case.



COMPONENT LOCATION - FUEL

POWERPLANT SYSTEM COMPONENT LOCATION (2)

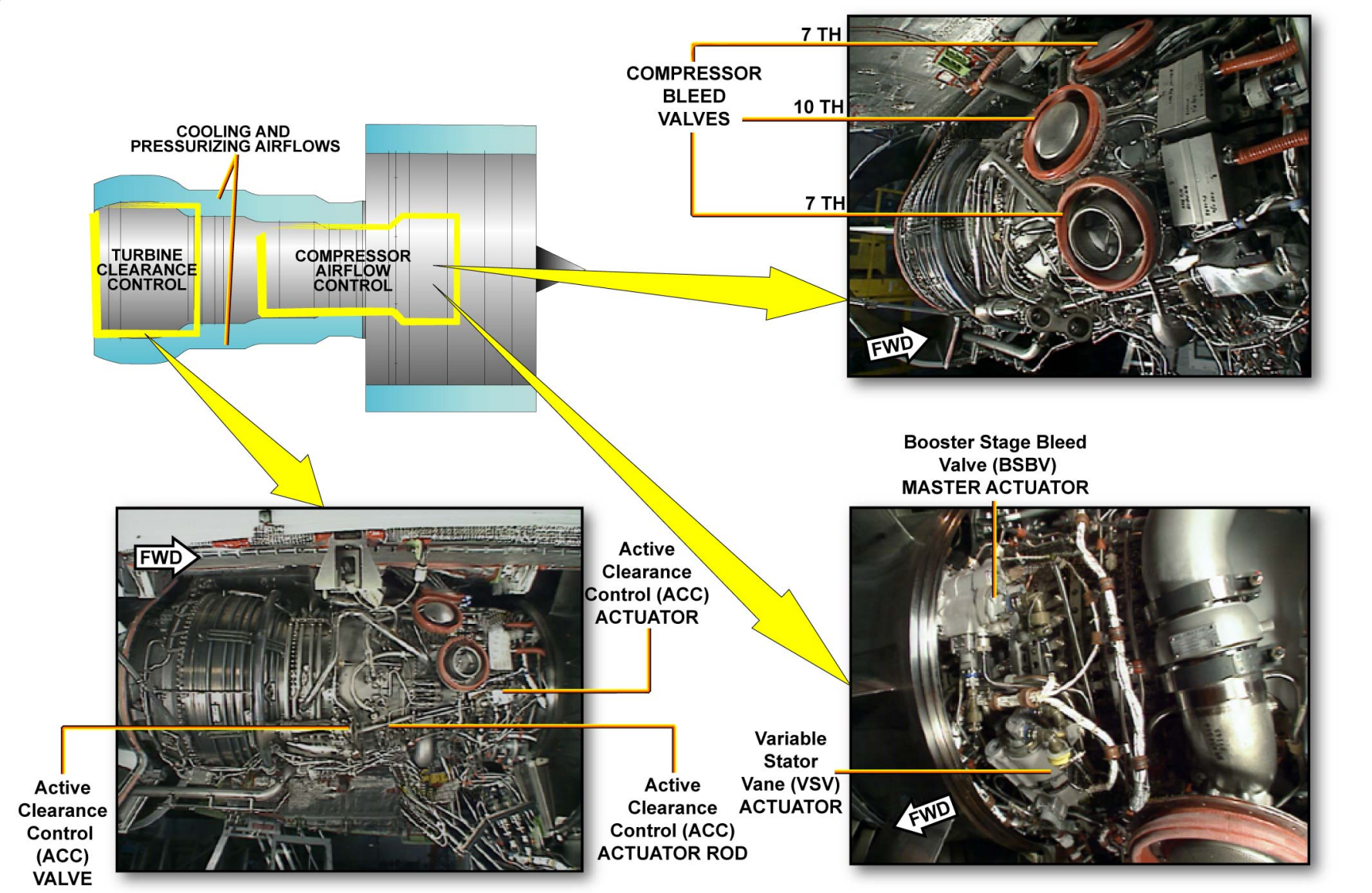
COMPONENT LOCATION (continued)

AIR

The next picture shows the compressor airflow control system and the turbine clearance control system.

On the LH side, there are 2 bleed valves for the 7th stage and one for the 10th stage of the HP compressor.

On the RH side, one more bleed valve is installed for the 7th stage.



COMPONENT LOCATION - AIR

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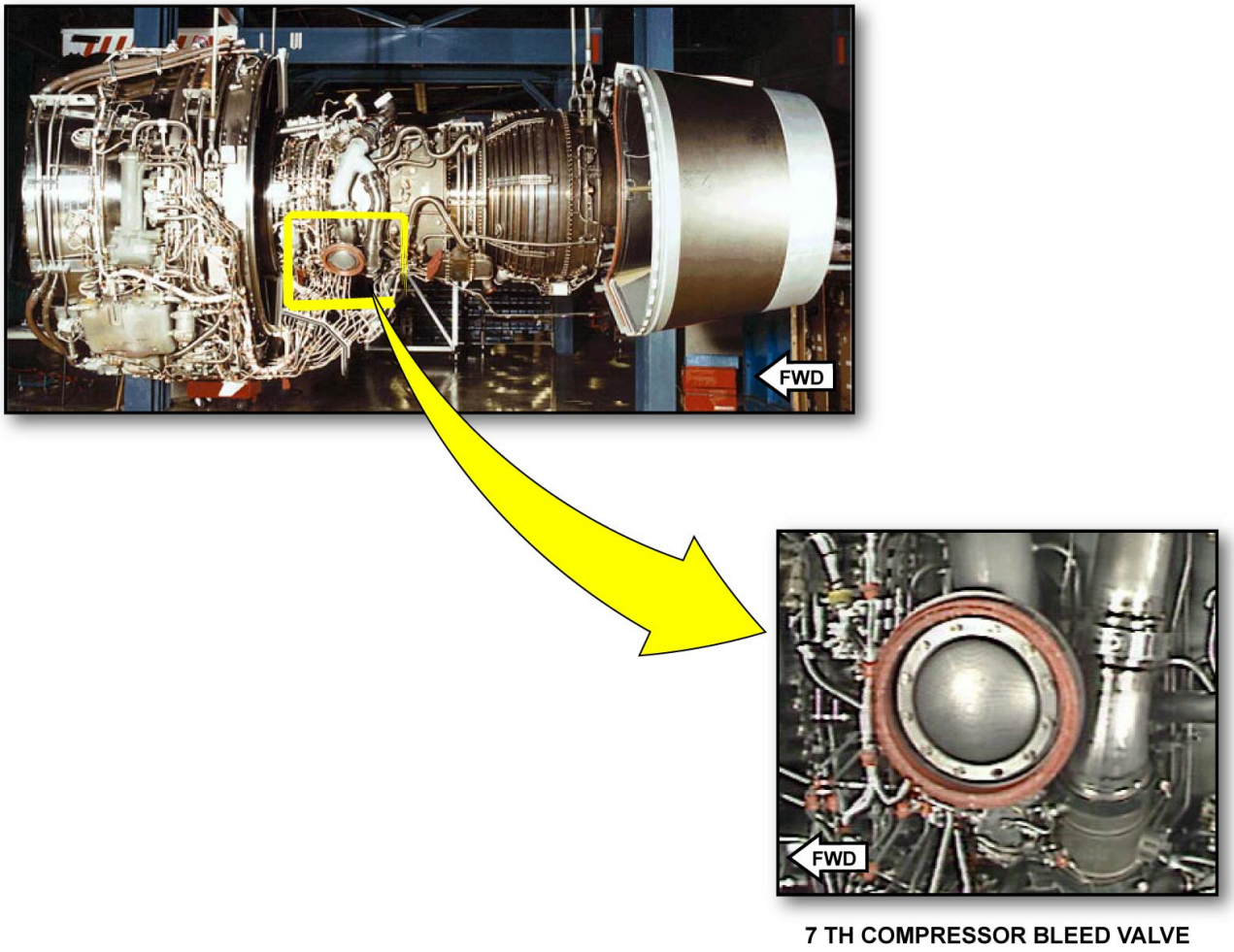

7 TH COMPRESSOR BLEED VALVE

COMPONENT LOCATION - AIR

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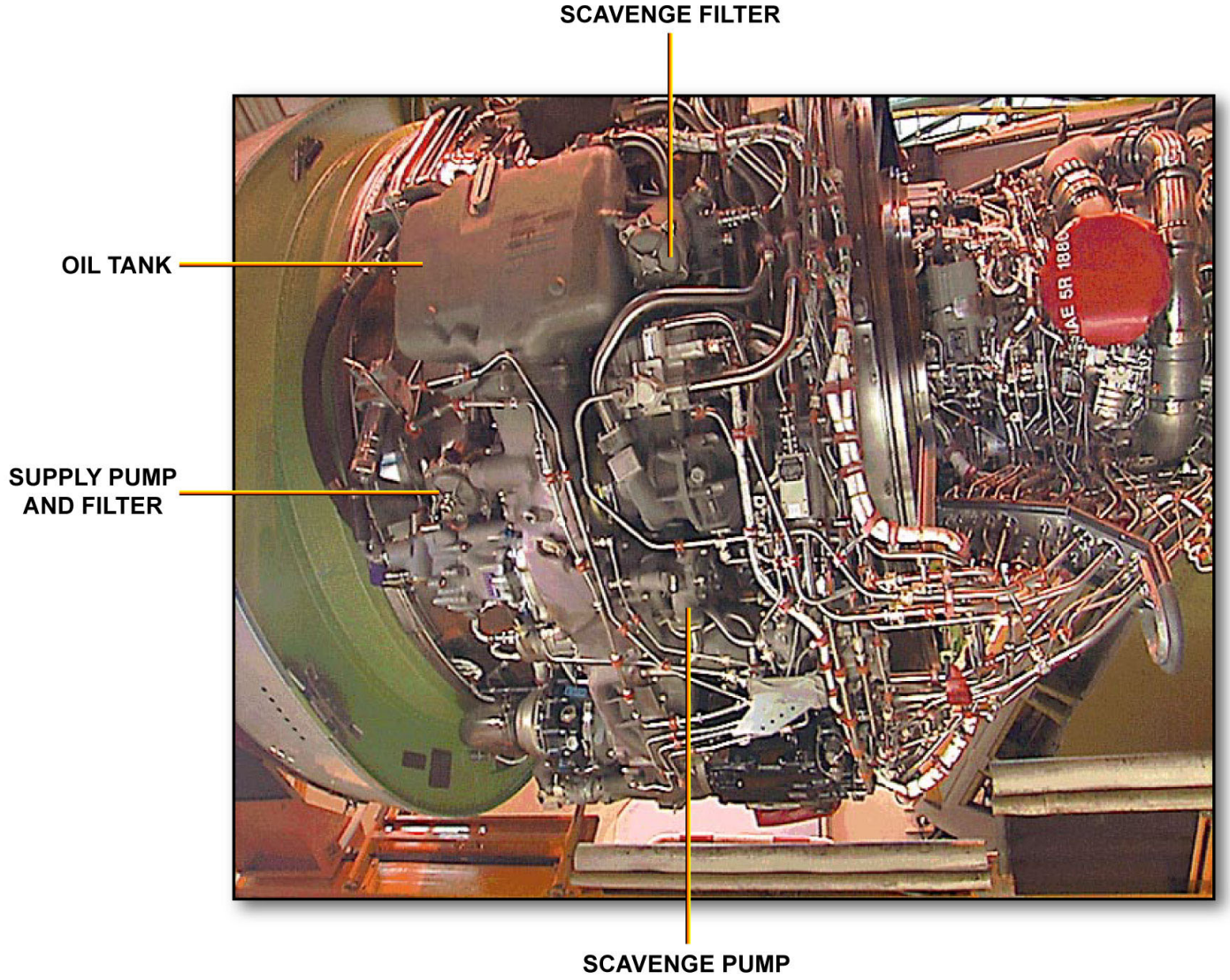
POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

OIL

The oil tank, the pressure pump, the scavenge pumps and the filter are on the gearbox.



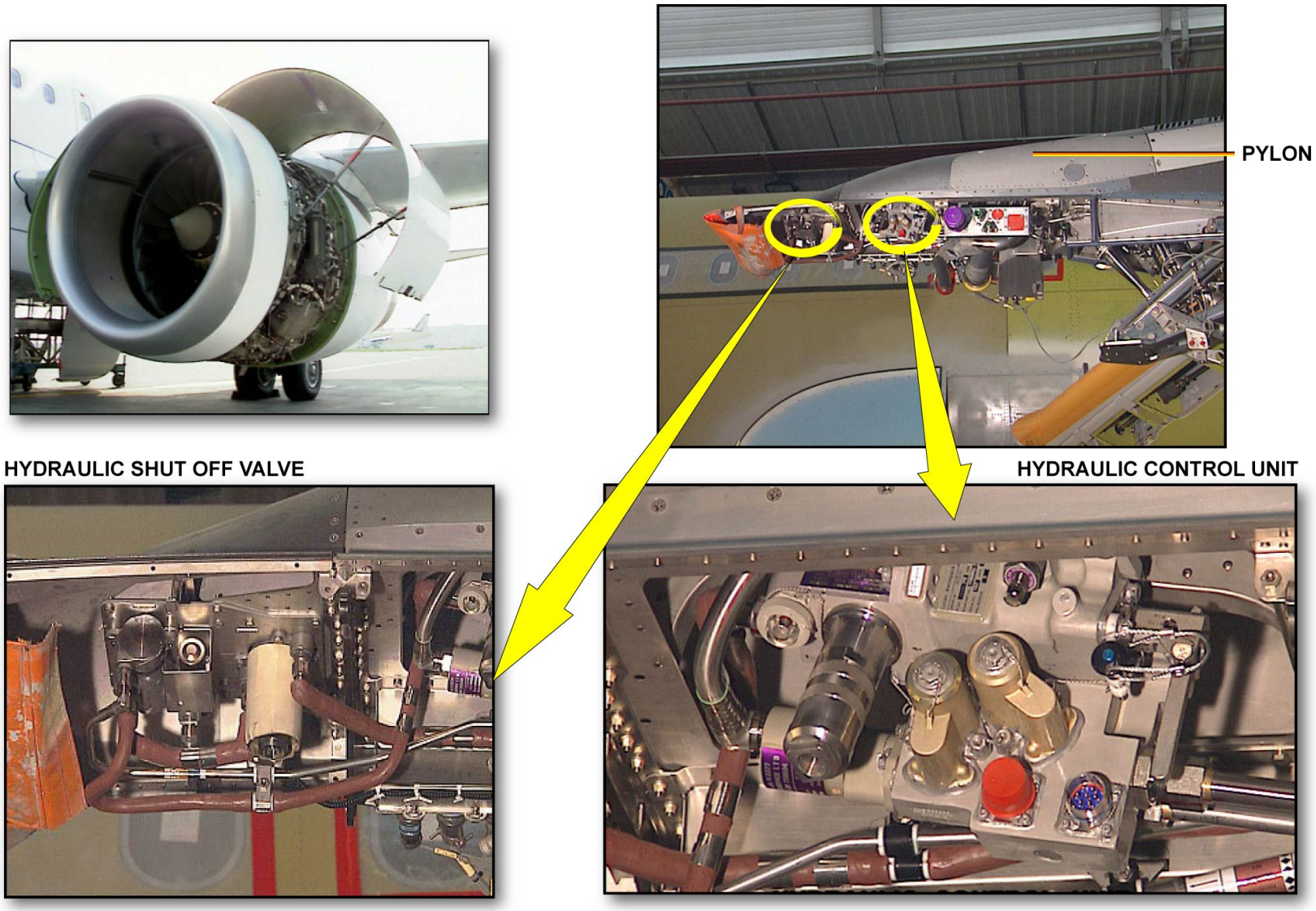
COMPONENT LOCATION - OIL

POWERPLANT SYSTEM COMPONENT LOCATION (2)

COMPONENT LOCATION (continued)

THRUST REVERSER

The hydraulic shut-off valve is in the front lower part of the pylon. The HCU is installed on the pylon above the engine centerline, immediately forward of the C-duct. Access to the HCU is done from the left side.



COMPONENT LOCATION - THRUST REVERSER

ENGINE SYSTEM CONTROL & INDICATING (IAE V2500) (2)

LOCATE CONTROL/INDICATING IN COCKPIT

FADEC POWERING / ENGINE CONTROLS

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FADEC PRESENTATION (2)

PURPOSE

The Full Authority Digital Engine Control (FADEC) system provides full range engine control throughout all flight and operational phases. It consists of a dual channel Electronic Engine Control (EEC) and its peripheral components and sensors.

FADEC FUNCTIONS

The FADEC provides the engine system regulation and scheduling to control the thrust and optimize the engine operation. The FADEC provides:
- power setting with EPR or N1 back-up mode,
- P2/T2 heating,
- acceleration and deceleration times,
- idle speed governing,
- overspeed limits for N1 and N2,
- Fuel Flow (FF) control,
- Variable Stator Vane system (VSV) control,
- compressor handling bleed valves control,
- booster stage bleed valve system control,
- High Pressure (HP)/Low Pressure (LP) turbine Active Clearance Control (ACC),
- automatic and manual engine starting,
- thrust reverser control,
- oil and fuel temperature management through the heat management system.

FADEC BENEFITS

The application of a FADEC system provides multiple benefits:
- it saves weight and fuel by a full range control of the gas generator,
- it reduces pilot workload and maintenance cost,
- it allows the optimum adaptation of thrust rating schedules to the A/C needs.

POWER SUPPLY

The FADEC system is self-powered by a dedicated Permanent Magnet Alternator (PMA) when N2 is greater than 10%. The EEC is powered by the aircraft 28 VDC electrical network for starting, as a backup and for testing with the engine not running. 115 VAC is used for the power supply of the ignition system and the P2/T2 probe heating. The PMA also provides the EEC Channel A and Channel B with the N2 rotation speed.

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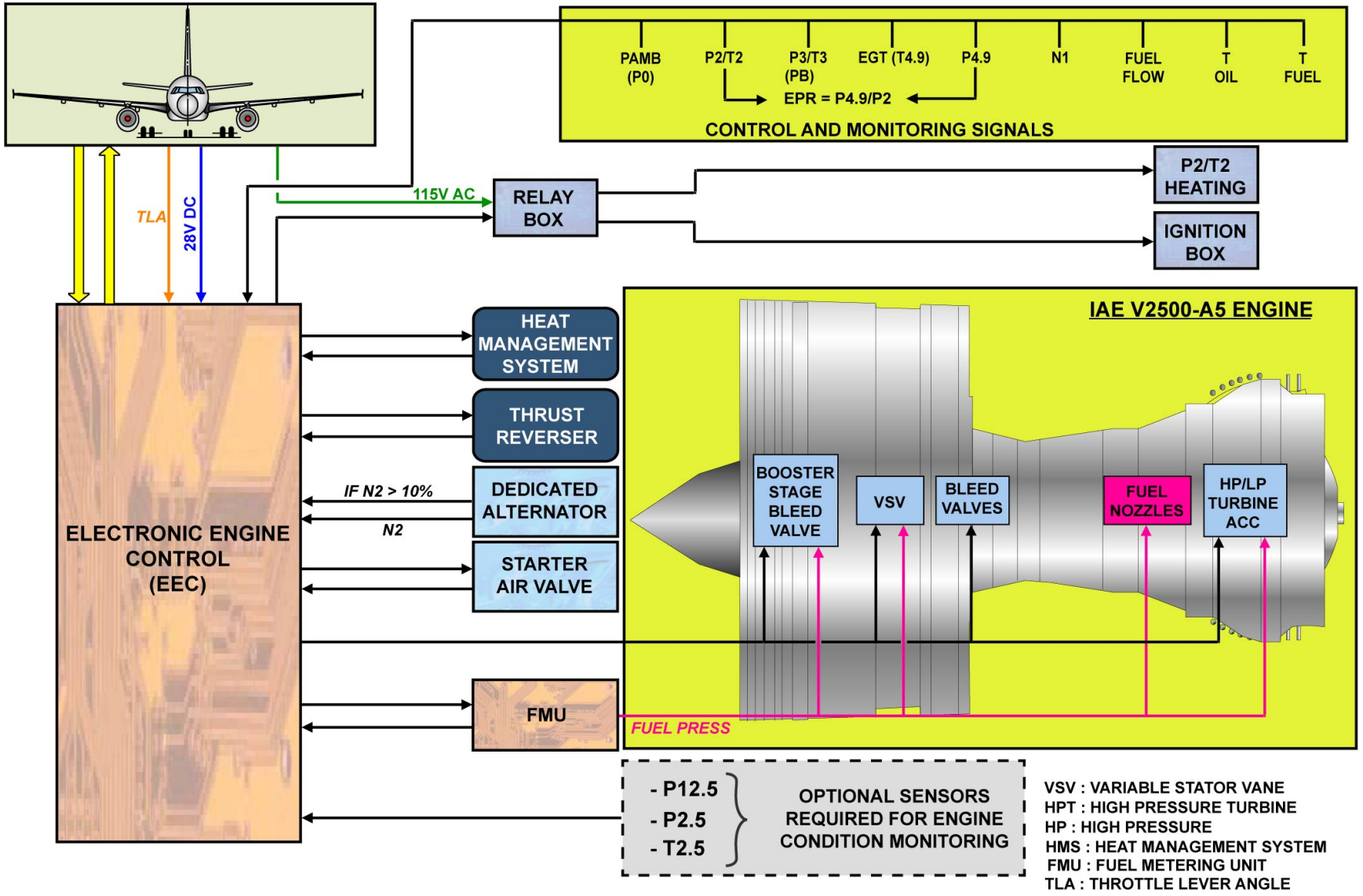

PURPOSE ... POWER SUPPLY

FADEC ARCHITECTURE (2)

DUAL CHANNEL

The Full Authority Digital Engine Control (FADEC) system is fully redundant and built around two independent control channels. Dual inputs, dual outputs and automatic switchover from one channel to the other eliminate any dormant failure. The Electronic Engine Control (EEC) consists of two channels A and B. Each channel can control the different components of the engine systems. Channels A and B are permanently operational. The channel in control manages the system.

DUAL INPUTS

All control inputs to the FADEC system are doubled. Only some secondary parameters used for monitoring and indicating are single. To increase the fault tolerant design, the parameters are exchanged between the two control channels inside the EEC via the cross channel data link.

HARDWIRED INPUTS

Most of the information exchanged between the A/C and the EEC is transmitted over digital data buses, some signals over a single line. In addition, some signals are hard-wired directly from the A/C to the EEC. The Throttle Lever Angle (TLA) is transformed by resolvers into a Throttle Resolver Angle (TRA) and transmitted directly to the EEC. 1° of TLA corresponds to 1.9° of TRA.

DUAL OUTPUTS

All the EEC outputs are double, but only the channel in control supplies the engine control signals to the various receptors such as torque motors and solenoids. The other channel calculation is used for crosschecking.

BITE CAPABILITY

The EEC is equipped with a BITE system which provides maintenance information and test capabilities via the MCDU.

FAULT STRATEGY

Using the BITE system, the EEC can detect and isolate failures. It also allows the EEC to switch engine control from the faulty channel to the healthy one. Depending on the nature of the failure, the EEC will behave differently in case of:
- single input signal failure, there is no channel changeover, the channel in control uses the inputs from the other channel through the cross channel data link,
- dual input signal failure, the system runs on synthesized values of the healthiest channel,
- single output signal failure, there is an automatic switchover to the standby active channel,
- complete output signal failure, there is no longer any current to drive the torque motors or solenoids, the related component will go to the "fail-safe" position.

FAIL-SAFE CONTROL

If a channel is faulty and the channel in control is unable to ensure one engine function, this control is moved to a fail-safe position. Example: if the channel is faulty and the remaining channel in control is unable to control the Variable Stator Vane (VSV) position, the vanes are set to the fail-safe open position.

MAIN INTERFACES

To perform all its tasks, the EEC interfaces with A/C computers, either directly or via the Engine Interface Unit (EIU), which is an interface

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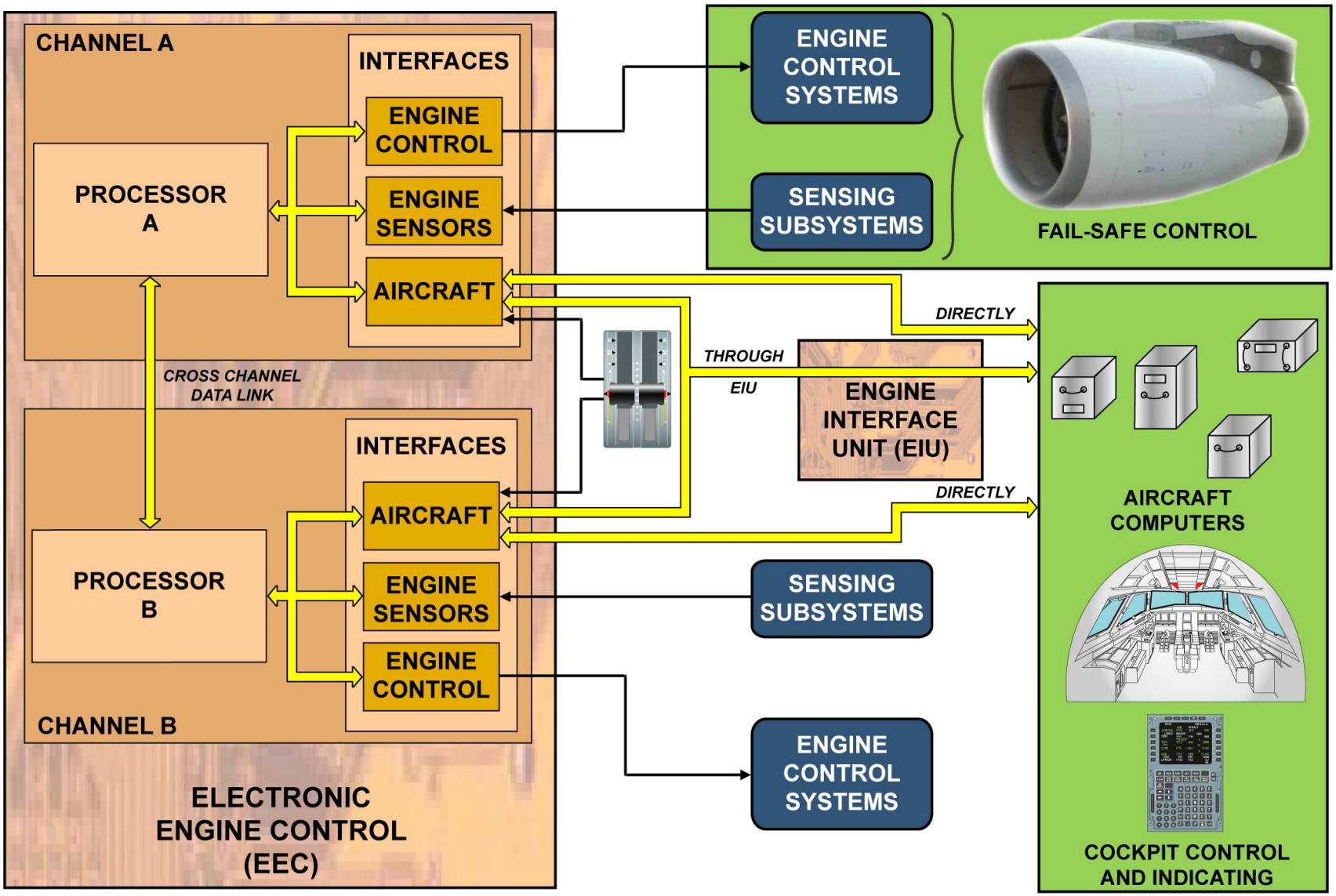
concentrator between the A/C systems and the FADEC system. There is one EIU for each engine, located in the avionics bay.

EEC INPUTS

The EEC receives inputs from:
- the Landing Gear Control and Interface Unit (LGCIU),
- the Air Data Inertial Reference Units (ADIRUs),
- the Flight Control Unit (FCU),
- the Environmental Control System (ECS) computers,
- the Centralized Fault Display Interface Unit (CFDIU),
- the cockpit engine controls including TRA, fire and anti-ice systems.

EEC OUPUTS

The EEC sends outputs to:
- the Bleed air Monitoring Computers (BMCs),
- the Electronic Control Box (ECB),
- the Flight Warning Computers (FWCs),
- the Display Management Computers (DMCs),
- the Flight Management and Guidance Computers (FMGCs),
- the CFDIU,
- the Data Management Unit (DMU), in option.



DUAL CHANNEL ... MAIN INTERFACES

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FADEC PRINCIPLE (2)

GENERAL

The Full Authority Digital Engine Control (FADEC) system manages the engine thrust and optimizes the performance.

FADEC

The FADEC consists of the Electronic Engine Control (EEC) and its peripheral components and sensors used for control and monitoring. The EEC is in relation with the other A/C systems through the Engine Interface Unit (EIU). The primary parameters Engine Pressure Ratio (EPR), Low Pressure Rotor Speed (N1), High Pressure Rotor Speed (N2), Exhaust Gas Temperature (EGT), and Fuel Flow (FF) are sent directly by the EEC to the ECAM.
Secondary parameters:
- the oil quantity and oil pressure are sent to the DMCs by the SDACs. In case of SDACs failure, the EIU sends data to DMCs by the FWCs,
- the oil temperature is sent by the EIU to DMCs via thhe FWCs,
- the fuel used data is directly sent to DMCs via the EEC,
- the vibration parameters are sent by the EIVMU to DMCs via the SDACs.

EIU

Each EIU, located in the avionics bay, is an interface concentrator between the airframe and the corresponding FADEC located on the engine. There is one EIU for each engine.

POWER MANAGEMENT

The FADEC provides automatic engine thrust control and thrust parameter limit computation. The thrust is computed according to the Engine Pressure Ratio (EPR) in normal mode or N1 in back-up mode. In fact, when the Engine Pressure Ratio (EPR) mode is no longer operational the FADEC automatically reverts to the N1 alternate control mode. The FADEC manages power according to two thrust modes:
- manual mode depending on the Throttle Resolver Angle (TRA),
- auto thrust mode depending on the auto thrust function generated by the Auto Flight System (AFS).
The FADEC also provides two idle mode selections:
- approach idle,
- minimum idle.
Approach idle is obtained when the slats are extended. Minimum idle can be modulated up to approach idle depending on air conditioning, engine anti-ice and wing anti-ice demands.

ENGINE LIMITS

The FADEC provides overspeed protection for N1 and N2, in order to prevent the engine from exceeding limits, and also monitors the EGT and Engine Pressure Ratio (EPR).

ENGINE SYSTEMS

The FADEC provides optimal engine operation by controlling the:
- FF,
- compressor airflow and turbine clearance.

IGNITION AND STARTING

The FADEC controls the engine start sequence. It monitors N1, N2, and EGT parameters and can abort or recycle an engine start. The FADEC controls the ignition and starting in automatic or manual mode when initiated from the ENGine start or ENGine MANual START panels.

THRUST REVERSER

The FADEC supervises the thrust reverser operation entirely.

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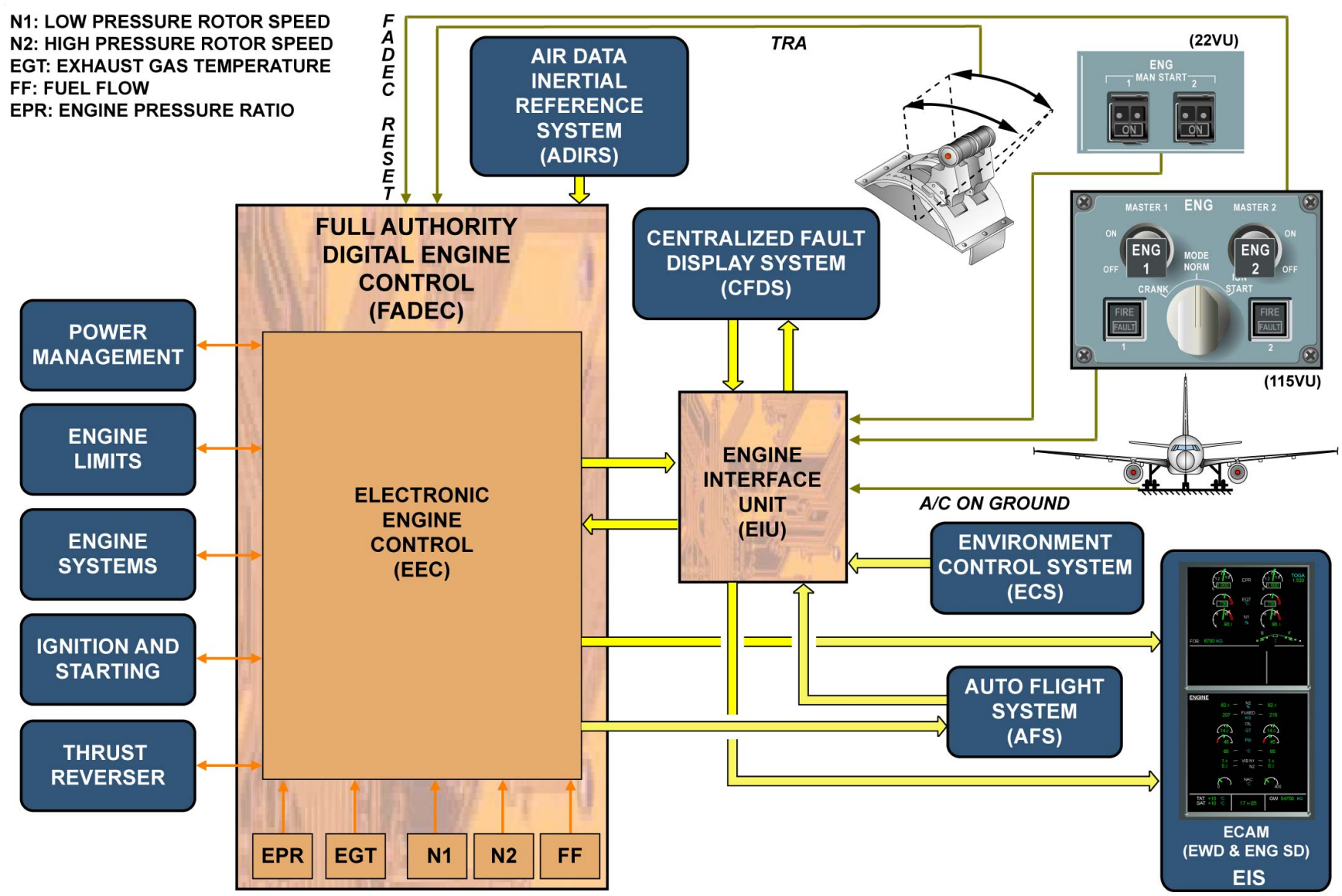
NOTE: Note: during reverse operation the thrust is controlled as a function of N1.



GENERAL ... THRUST REVERSER

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EEC INTERFACES (3)

GENERAL

In order to provide a full range of engine control and monitoring, the Electronic Engine Control (EEC) interfaces with the following sub systems:
- air data computers, which transmit air data for engine control,
- Engine Interface Unit (EIU), which concentrates A/C signals and transmits them to the EEC,
- for cockpit indication and control, and autothrust control, the EEC sends signals to computers,
- engine sensors and controls.

DIGITAL INPUTS

Inputs of each channel are isolated in order to prevent failure propagation. Each channel receives inputs for both the Air Data/Inertial Reference Units (ADIRUs) and the EIU. The EEC performs a fault detection on its input parameters by determining if they are valid. This check is made by applying a range of tests to each input. Faults detected by the EEC are annunciated and recorded for maintenance or crew action, if required. The ADIRUs send air data parameters to the EEC for engine control. The EEC performs validation tests and selection logic between air data signals from the ADIRUs and the engine sensors. ADIRU data is preferred over engine data. The air data used to validate Altitude (P0), Total Air Temperature (TAT), TOTal PRESSure, mach for the power management and engine controls are:
- TAT, TOTal PRESSure, P0, mach number, from the ADIRUs,
- P2, T2 and P0 from engine sensors.

DIGITAL OUTPUTS

Each channel has 2 output ports and each bus has a separated line driver, i.e. A1, A2, B1, B2, in such a way that propagation of failures is prevented. The EEC output buses provide:
- engine control parameters,
- engine condition monitoring parameters,
- EEC status and fault indication,
- engine rating parameters,
- Full Authority Digital Engine Control (FADEC) system maintenance data.

The EEC transmits outputs continuously on all buses in normal operation, irrespective of whether the given channel is in active control or not. The parameter values on the 2 output buses are normally identical as long as the cross channel data link is functioning.

NOTE: Channel switchover does not affect the output data of the EEC.

DISCRETE/ANALOG SIGNALS

The EEC receives the Throttle Resolver Angle (TRA) signals, the autothrust instinctive disconnect switch signals and engine sensor signals. They are validated by the EEC. The EEC also sends signals to the engine controls. The resolvers of the Throttle Control Unit (TCU) receive an excitation current from the EEC. The EEC checks the range limits, the rate limits and performs an interface fault detection test.

NOTE: 1 degree TLA corresponds to 1.9 degree TRA.

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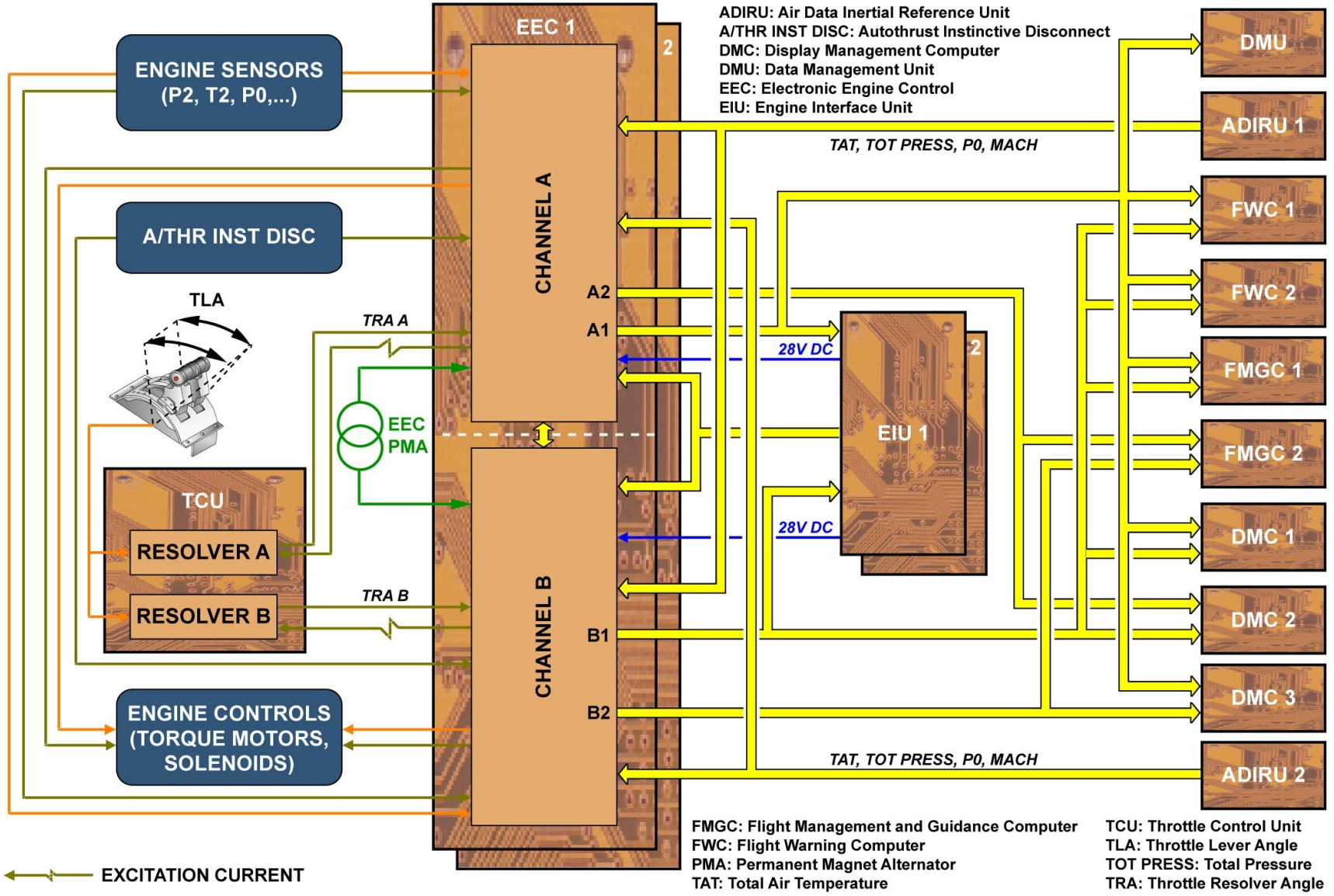
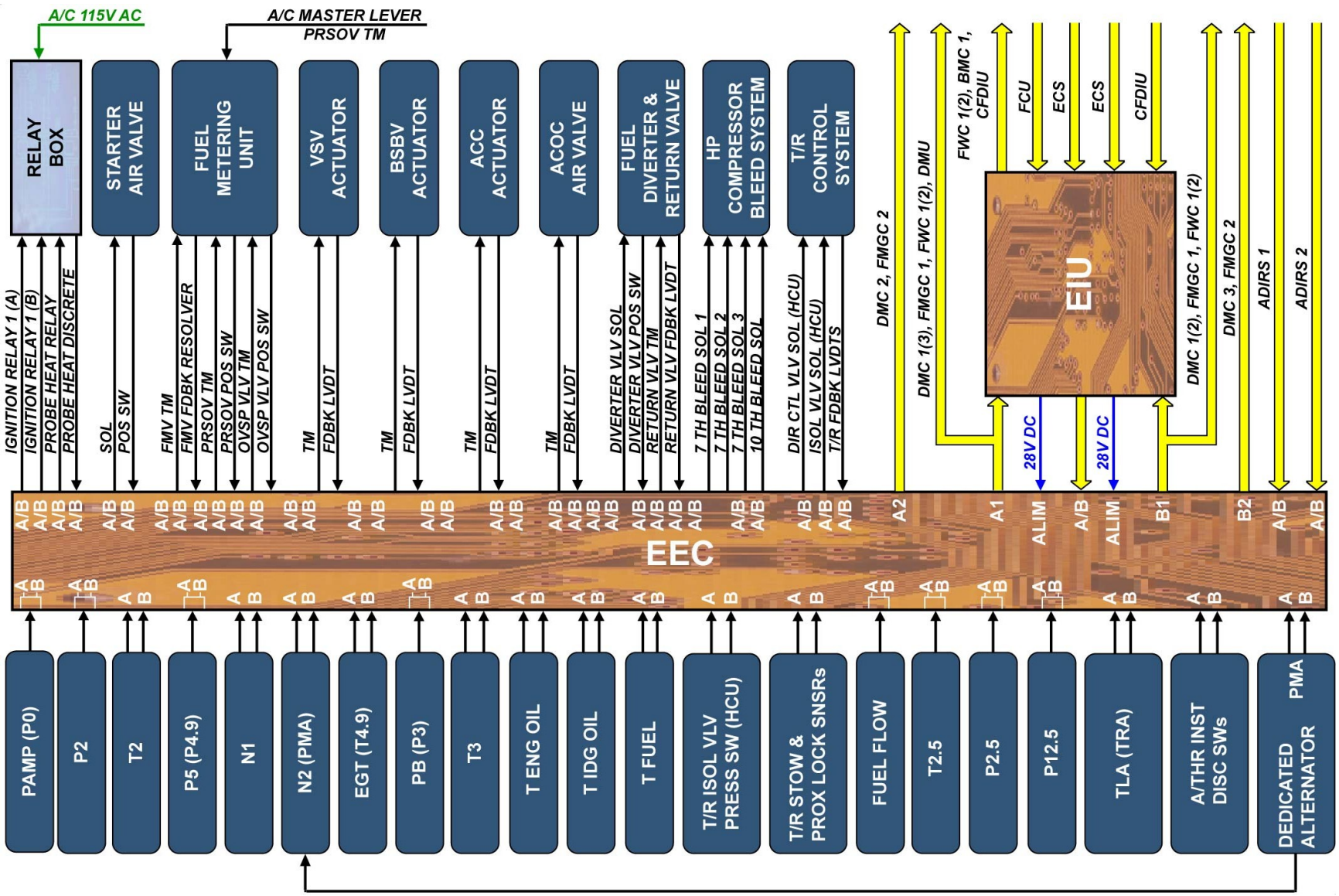


GENERAL ... DISCRETE/ANALOG SIGNALS

EEC INTERFACES (3)

BLOCK DIAGRAM

Here are the interfaces between the EEC and the A/C in the form of a block diagram.



BLOCK DIAGRAM

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EIU INTERFACES (3)

GENERAL

There are 2 Engine Interface Units (EIUs), one for each engine. The EIU is an interface concentrator between the A/C and the Full Authority Digital Engine Control (FADEC) system. The main functions of the EIU are:
- to concentrate data from the cockpit panels,
- to ensure the segregation of the 2 engines,
- to provide the Electronic Engine Control (EEC) with an electrical power supply,
- to give the necessary logic and information from the engine to the aircraft systems.

EIU COMPOSITION

The EIU is composed of 5 main parts:
- discrete and analog inputs,
- digital inputs,
- digital outputs,
- discrete outputs,
- power supply switching.

EIU FUNCTIONS

The EIU performs the following:
- acquisition of information,
- transmission of messages,
- logics for Low Oil Pressure (LOP) and Auxiliary Power Unit (APU) boost,
- fault detection logic carried out by an internal BITE and transmission of the result to the Centralized Fault Display System (CFDS).

INPUTS

The EIU receives the following:
- discrete signals which are of the ground/open circuit type,
- analog inputs which are of the differential type with a working range of 1 to 9 volts,
- digital inputs on ARINC 429 lines.

OUTPUTS

The EIU sends the following:
- digital output signals on ARINC 429 buses,
- discrete signals which are of the 28V DC/open circuit or ground/open circuit types.

EEC INTERFACE

The EIU receives 2 ARINC 429 output data buses from EEC channels A and B and it uses data from the channel in control. If some data is not available from the control channel, data from the other channel is used. The EIU looks at particular engine data on the EEC digital data flow to interface this with other aircraft computers and with cockpit panels for control and monitoring. The EIU sends information, coming from all aircraft computers, which have to communicate with the EEC, through an output ARINC 429 data bus. The EIU does not deal with Air Data/Inertial Reference Unit (ADIRU) and thrust lever information as they communicate directly with the EEC.

NOTE: Note: There is no data flow during the EIU internal test or initialization.

ECS INTERFACE

The EIU receives two inputs from the Air Conditioning System Controller (ACSC) 1 and 2 of the Environmental Control System (ECS).
The ECS determines the various air bleed configurations according to logics of the air conditioning, wing anti-ice and nacelle anti-ice. This information is transmitted by the EIU to the EEC to compute the bleed air demand required at the engine customer bleed ports.

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ENGINE START CONTROL

The EIU receives and generates all starting signals from the cockpit engine panels. Therefore engine starting is not possible in case of EIU failure. The control panels provide the EIU with the following signals:
- engine start mode selector position,
- master lever position,
- manual start P/B.

The EIU provides all starting signals to the EEC and to the ENGine start panel FAULT light.

CFDS INTERFACE

The Centralized Fault Display Interface Unit (CFDIU) communicates with the BITE memory of the EIU and with the BITE memory of the EEC via the EIU. The EIU interfaces with the CFDIU to generate the EIU and the FADEC fault messages on the MCDU. To access the FADEC menu function, the CFDS interrogates the EEC BITE memory through the EIU.

BMC INTERFACE

There is an interface between the EIU and the pneumatic system Bleed Monitoring Computer (BMC) for engines 1 and 2. During engine start, the EIU generates a ground signal for the BMC when the start valve moves away from the closed position. On receipt of this ground signal, the BMC closes the pneumatic system Pressure Regulating Valve (PRV).

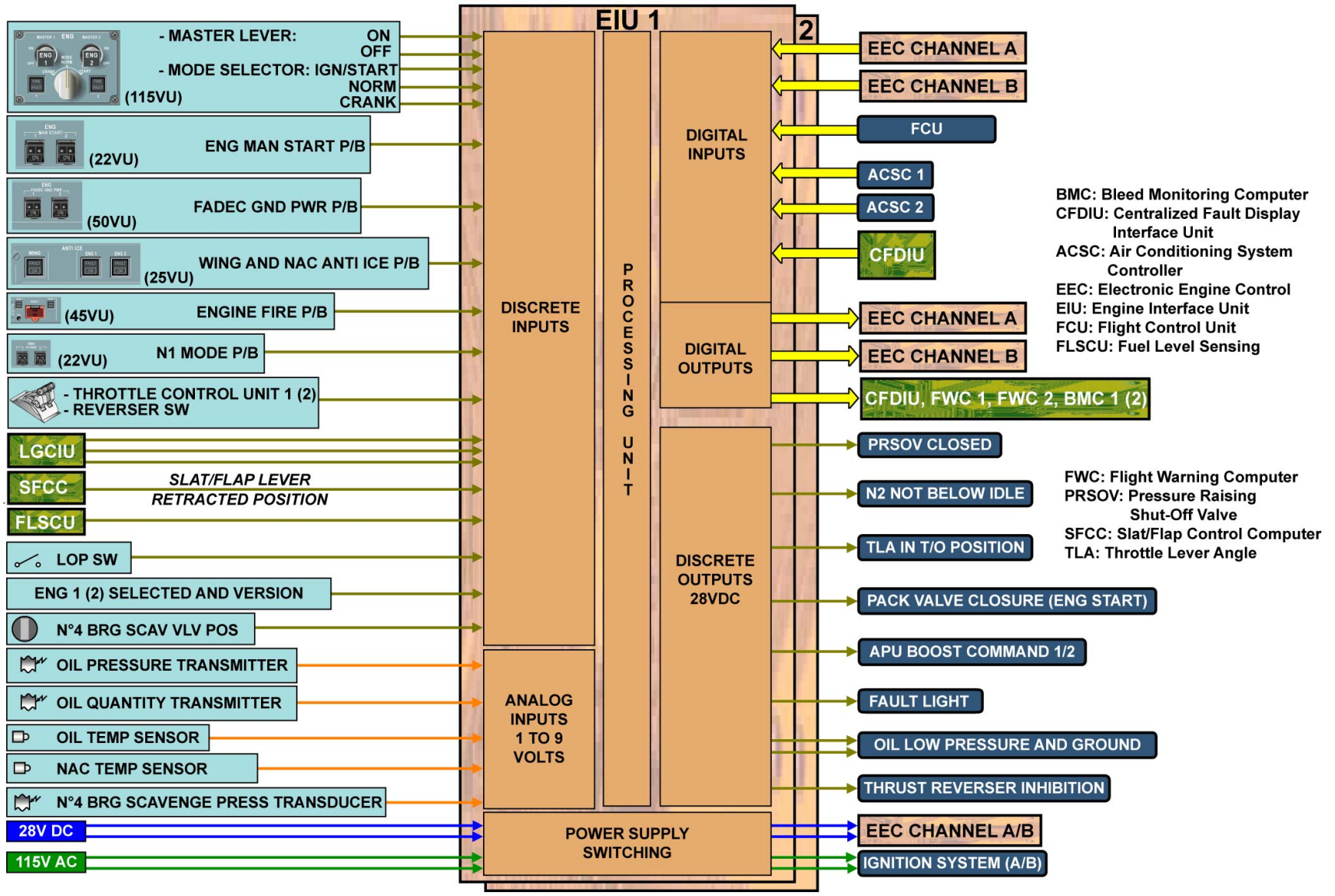
OTHER INTERFACES

The EIU also receives other signals from various aircraft systems for control and monitoring purposes. The EIU also generates signals for various aircraft systems.

POWER SUPPLY

The EIU receives the following:
- 28V DC for its own power supply and for the FADEC power supply,
- 115V AC for engine ignition system power supply.

NOTE: Note: In case of EIU failure, the power supply for FADEC and ignition is preserved (fail safe position).



GENERAL ... POWER SUPPLY

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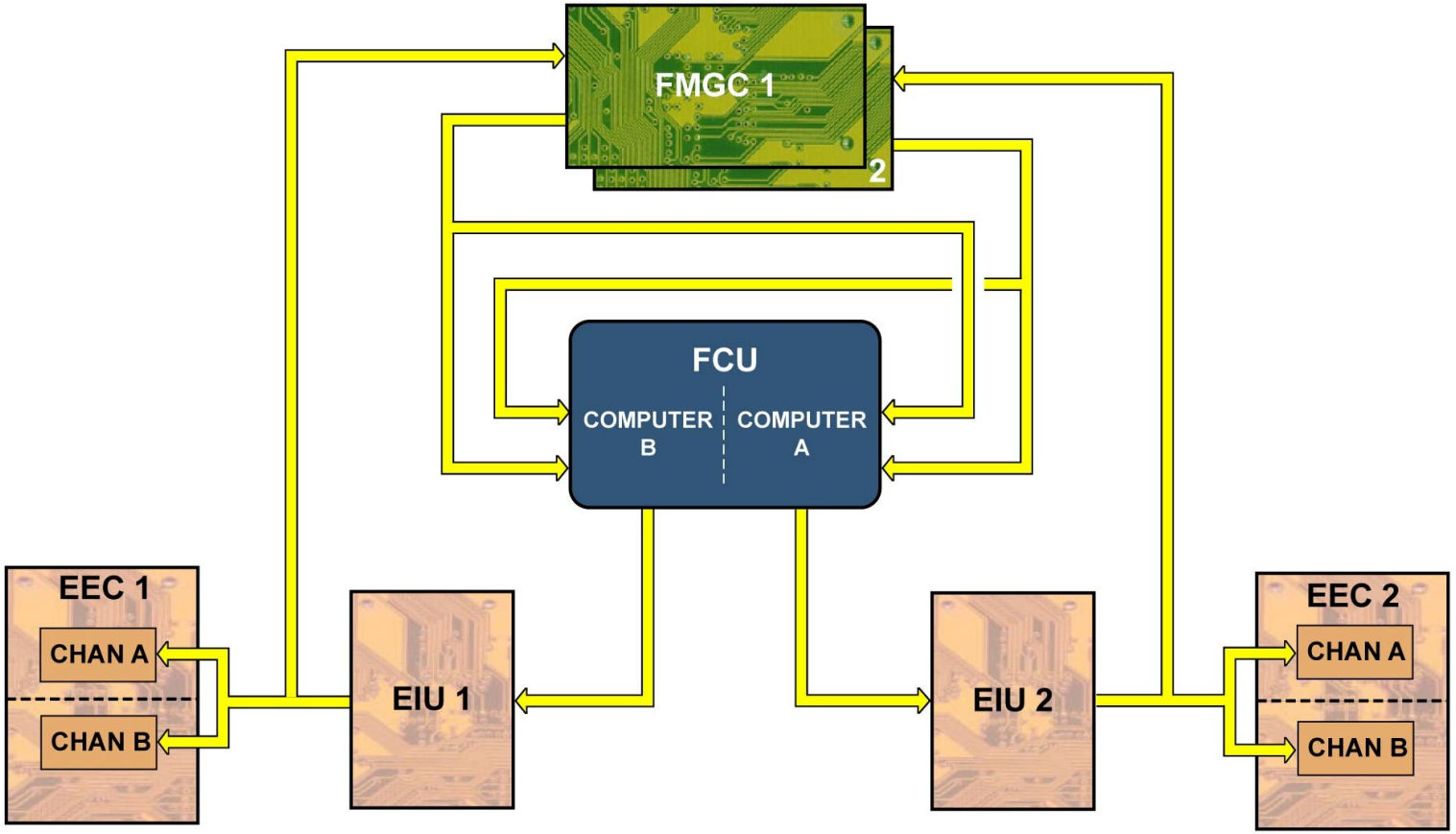
EIU INTERFACES (3)

FMGS

The AutoTHRust (A/THR) function is provided by the Flight Management and Guidance System (FMGS). Therefore, the FMGS sends all command signals for engine power management via the Flight Control Unit (FCU) and both EIUs. The FMGS assumes the following functions:
- computation of Engine Pressure Ratio (EPR) target,
- selection of A/THR modes,
- alpha floor protection,
- flexible takeoff,
- A/THR engagement.

FEEDBACK

The EEC directly sends specific feedback outputs to the FMGS without going through the EIU. The EIU also receives this data but does not transmit it to FMGS. The EEC feedback output data to Flight Management and Guidance Computer (FMGC) is as follows:
- Thrust Resolver Angle (TRA),
- EPR command,
- EPR actual,
- EPR target in feedback,
- EPR limit,
- EPR max,
- EPR reference throttle,
- thrust mode,
- Fuel Flow (FF),
- bleed configuration in feedback,
- engine rating identification,
- flexible temperature in feedback.



EEC: Electronic Engine Control
EIU: Engine Interface Unit
FCU: Flight Control Unit
FMGC: Flight Management and Guidance Computer

FMGS - FEEDBACK

EEC ELECTRICAL PWR SPLY CONTROL (3)

GENERAL

The Electronic Engine Control (EEC) is electrically supplied by:
- the A/C network when High Pressure Rotor Speed (N2) is below 10% or when the dedicated alternator has failed,
- the dedicated alternator when N2 is above 10%.

POWERING N2 < 10%

The EEC is supplied by the A/C electrical power network when N2 is below 10%. Each channel is independently supplied by the A/C 28V DC through the Engine Interface Unit (EIU). The aircraft 28V DC permits:
- automatic ground check of the Full Authority Digital Engine Control (FADEC) system before the engine is running, that is to say FADEC GrouND PoWeR ON,
- engine starting: MASTER lever ON or mode selector on IGNition or CRANK,
- powering the EEC while the engine reaches 10% of N2.

NOTE: Note: the EIU takes its power from the same bus bar as the EEC.

POWERING N2 > 10%

As soon as the engine is running above 10% of N2, the dedicated alternator directly supplies the EEC. The dedicated alternator supplies each channel with three-phase AC power. Two transformer rectifiers provide 28V DC power supply to channels A and B. Switching between the A/C 28V DC supply and the dedicated alternator power supplies is done automatically by the EEC.

AUTO DEPOWERING

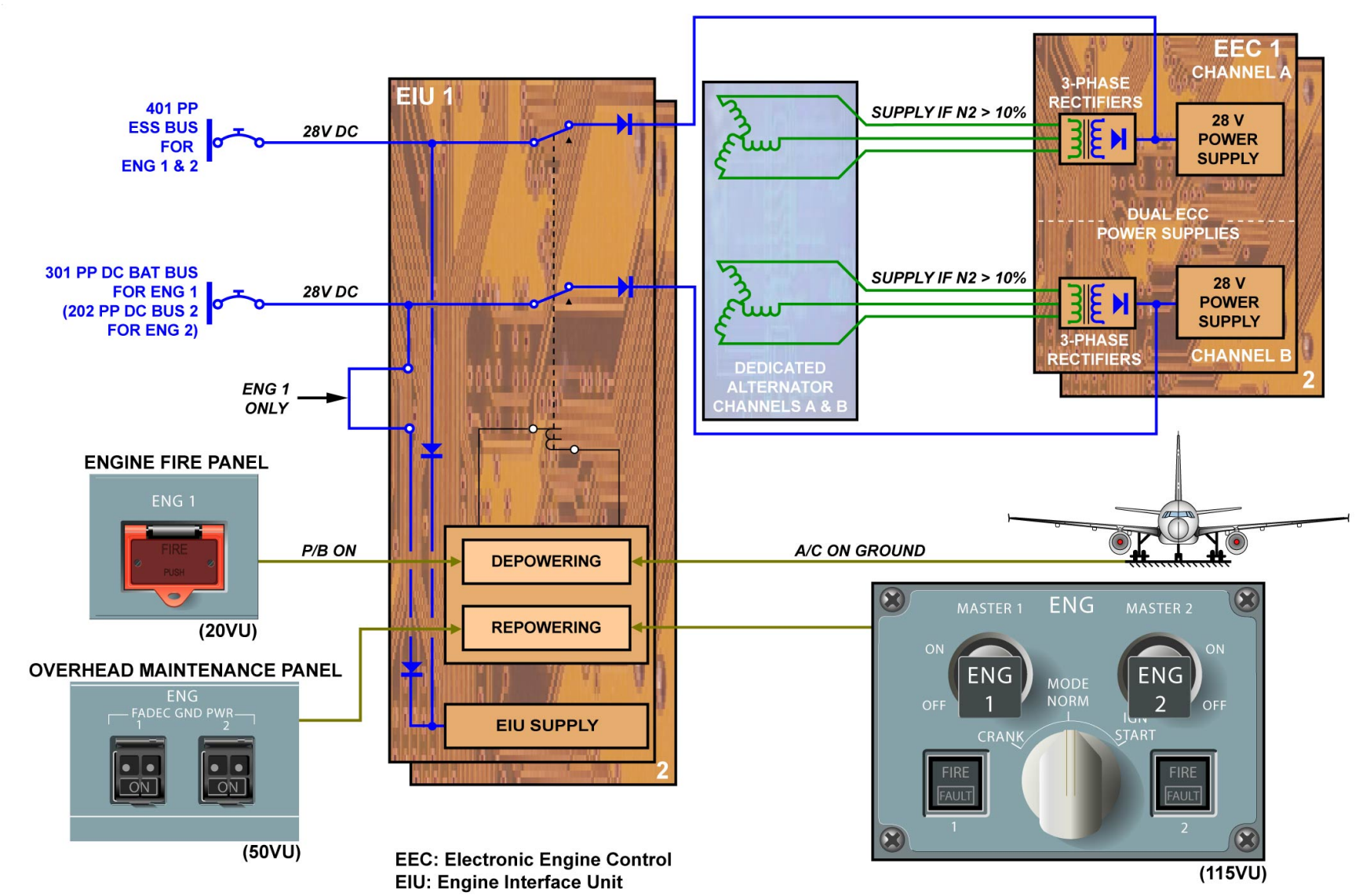
The FADEC is automatically depowered on the ground, through the EIU, after engine shutdown. EEC automatic depowering occurs on the ground:
- 5 min after A/C power-up,
- 5 min after engine shutdown.

NOTE: Note: An action on the ENGine FIRE P/B provides EEC power cut-off from the A/C network.

MANUAL REPOWERING

For maintenance purposes and MCDU engine tests, the ENGine FADEC GrouND PoWeR panel permits FADEC power supply to be restored on the ground with engines shut down. When the corresponding ENGine FADEC GrouND PoWeR P/B is pressed ON the EEC recovers its power supply.

NOTE: Note: The FADEC is also repowered as soon as the engine start selector is in IGNition/START or CRANK position, or the MASTER lever is selected ON.



GENERAL ... MANUAL REPOWERING

IGNITION & STARTING SYSTEM PRESENTATION (2)

GENERAL

The ignition system provides the electrical spark needed to start or continue engine combustion. The ignition system is made up of two independent subsystems energized by a relay box. Each subsystem includes an ignition exciter, a coaxial shield ignition lead and an igniter plug. The pneumatic starting system drives the engine High Pressure (HP) rotor at a speed high enough for a ground or in flight start to be initiated. The start system is made up of the start valve and the starter.

CONTROL AND INDICATING

The Electronic Engine Control (EEC) controls the ignition through the relay box and starting through the start valve, either in automatic or manual mode. The operation of the start valve and of the ignition system is displayed on the ENGINE ECAM page.

AUTOMATIC START

During an automatic start, the EEC opens the start valve, then the ignition exciter is energized when the HP rotor speed is nominal. The EEC provides full protection during the start sequence. When the automatic start is completed, the EEC closes the start valve and cuts off the ignition. In case of an incident during the automatic start the EEC aborts the start procedure.

MANUAL START

During a manual start, the start valve opens when the engine MANual START P/B is pressed in, then the ignition system is energized when the MASTER control lever is set to the ON position.

NOTE: there is no automatic shutdown function in manual mode.

CRANKING

Engine motoring could be performed for dry cranking or wet cranking sequences.

NOTE: during cranking ignition is inhibited.

CONTINUOUS IGNITION

With engine running, continuous ignition can be selected via the EEC either manually using the rotary selector or automatically by the Full Authority Digital Engine Control (FADEC).

SAFETY PRECAUTIONS

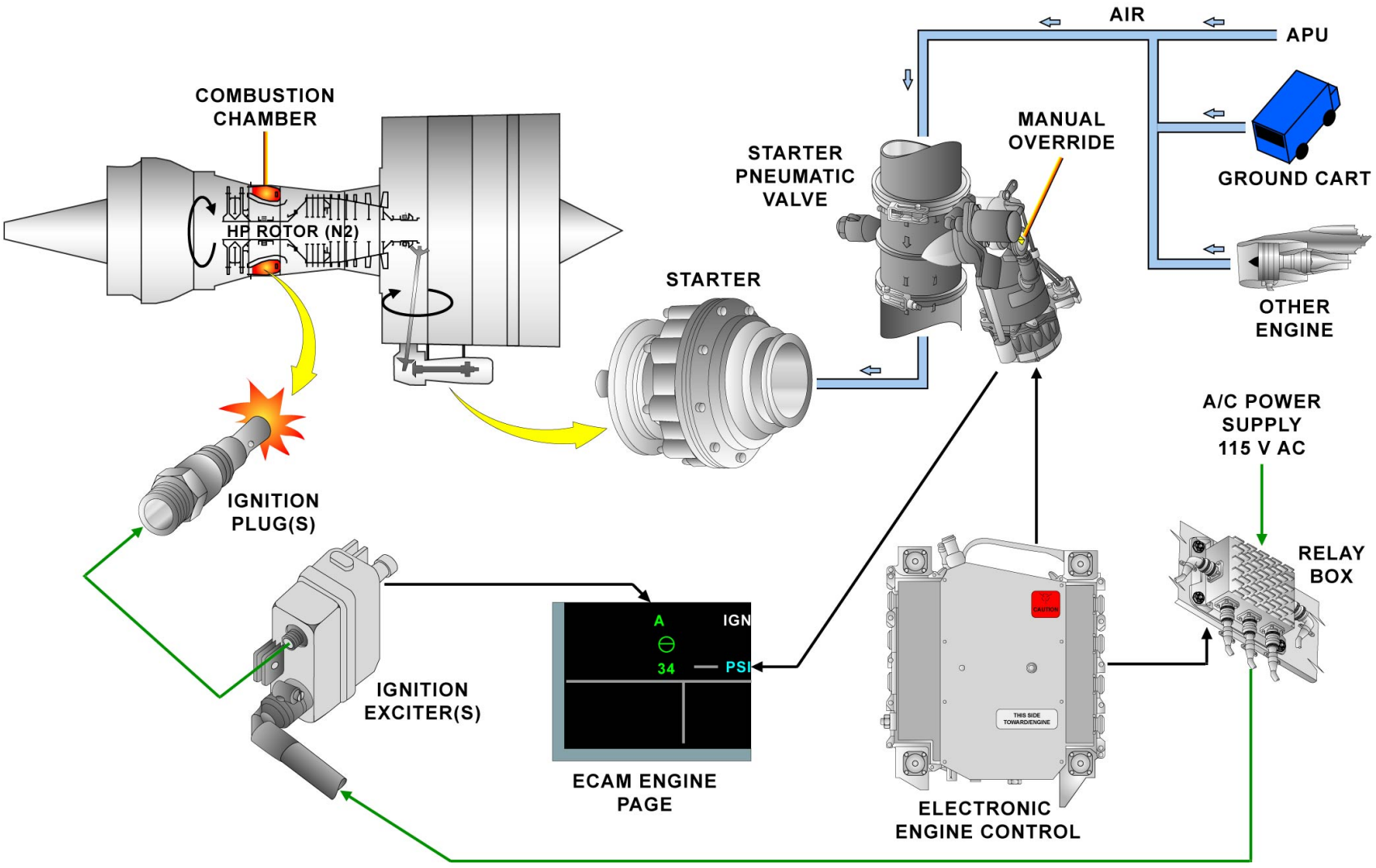
Safety precautions have to be taken prior to working in this area.

WARNING: THE EEC AND THE RELAY BOX SEND 115 VOLTS TO THE IGNITION BOXES, WHICH CONVERT IT AND SEND HIGH ENERGY PULSES THROUGH THE IGNITION LEADS TO THE IGNITERS PLUGS.

MAINTENANCE PRACTICES

To increase A/C dispatch, the start valve is equipped with a manual override. For this manual operation, the mechanic has to be aware of the engine safety zones.

UGB13131 - U64T2M0 - UM74P11AE000002



GENERAL ... MAINTENANCE PRACTICES

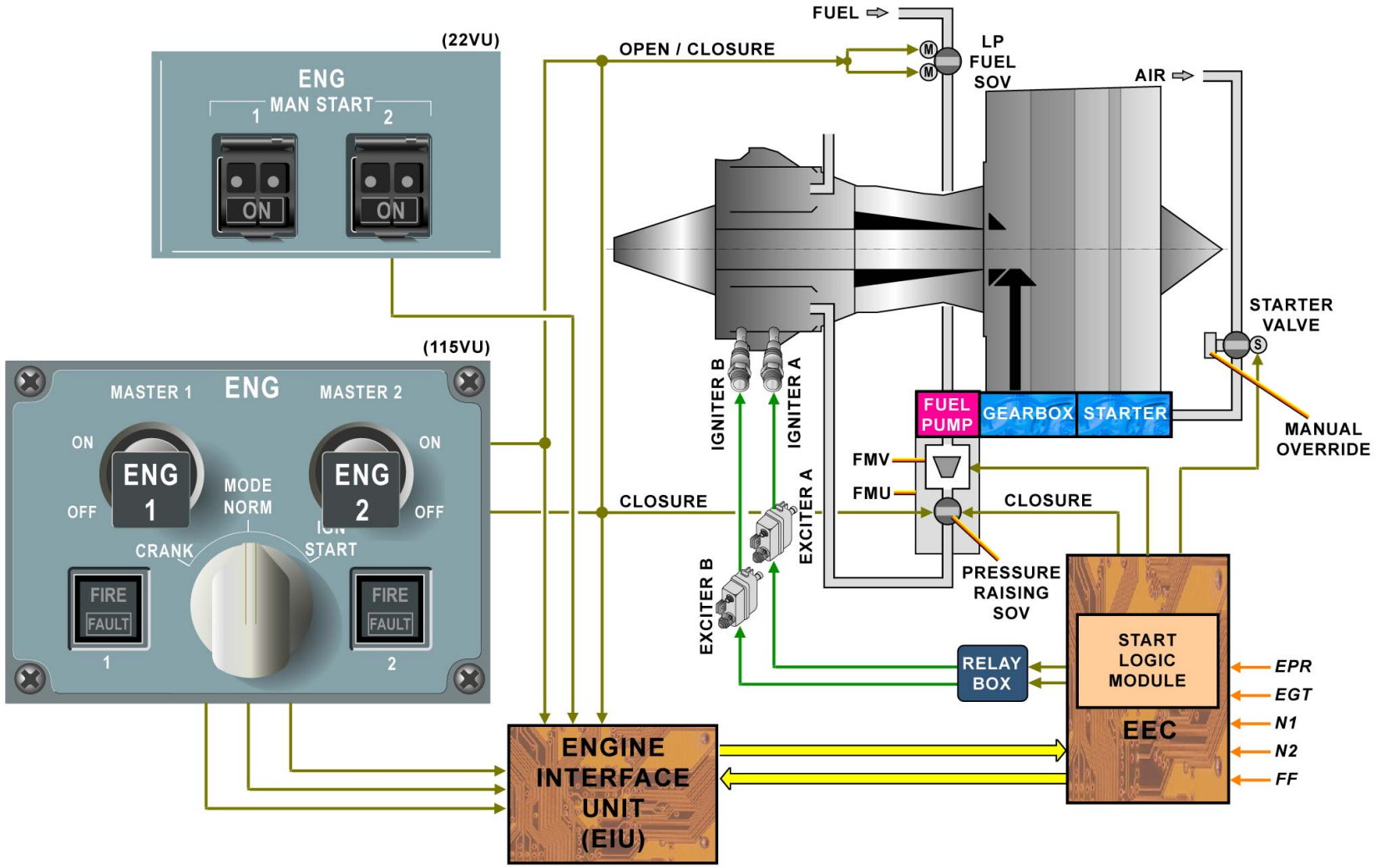
IGNITION & STARTING SYSTEM D/O (3)

GENERAL

The Electronic Engine Control (EEC) controls and monitors the start sequence either in automatic or in manual mode.
The start sequence is aborted below 50% N2 in case of:
- starter valve failure,
- ignition failure,
- pressure raising Shut-Off Valve (SOV) failure,
- hot start,
- hung start,

The system consists of a starter valve, a pneumatic starter, a relay box, two ignition exciters and igniters A and B. The starter valve is fitted with a manual override for mechanic operation on ground.

UGB13131 - U64T2M0 - UM74D1IAE000003


(22VU)
ENG
MAN START
1
2
ON
ON
(115VU)
MASTER 1
ENG
MASTER 2
ON
ENG
1
OFF
MODE
NORM
ON
ENG
2
OFF
CRANK
START
FIRE
FAULT
1
FIRE
FAULT
2
FUEL
OPEN / CLOSURE
LP
FUEL
SOV
AIR
STARTER
VALVE
MANUAL
OVERRIDE
IGNITER B
IGNITER A
FUEL
PUMP
GEARBOX
STARTER
FMV
FMU
CLOSURE
CLOSURE
EXCITER A
EXCITER B
PRESSURE
RAISING
SOV
RELAY
BOX
START
LOGIC
MODULE
EEC
EPR
EGT
N1
N2
FF
ENGINE
INTERFACE
UNIT
(EIU)

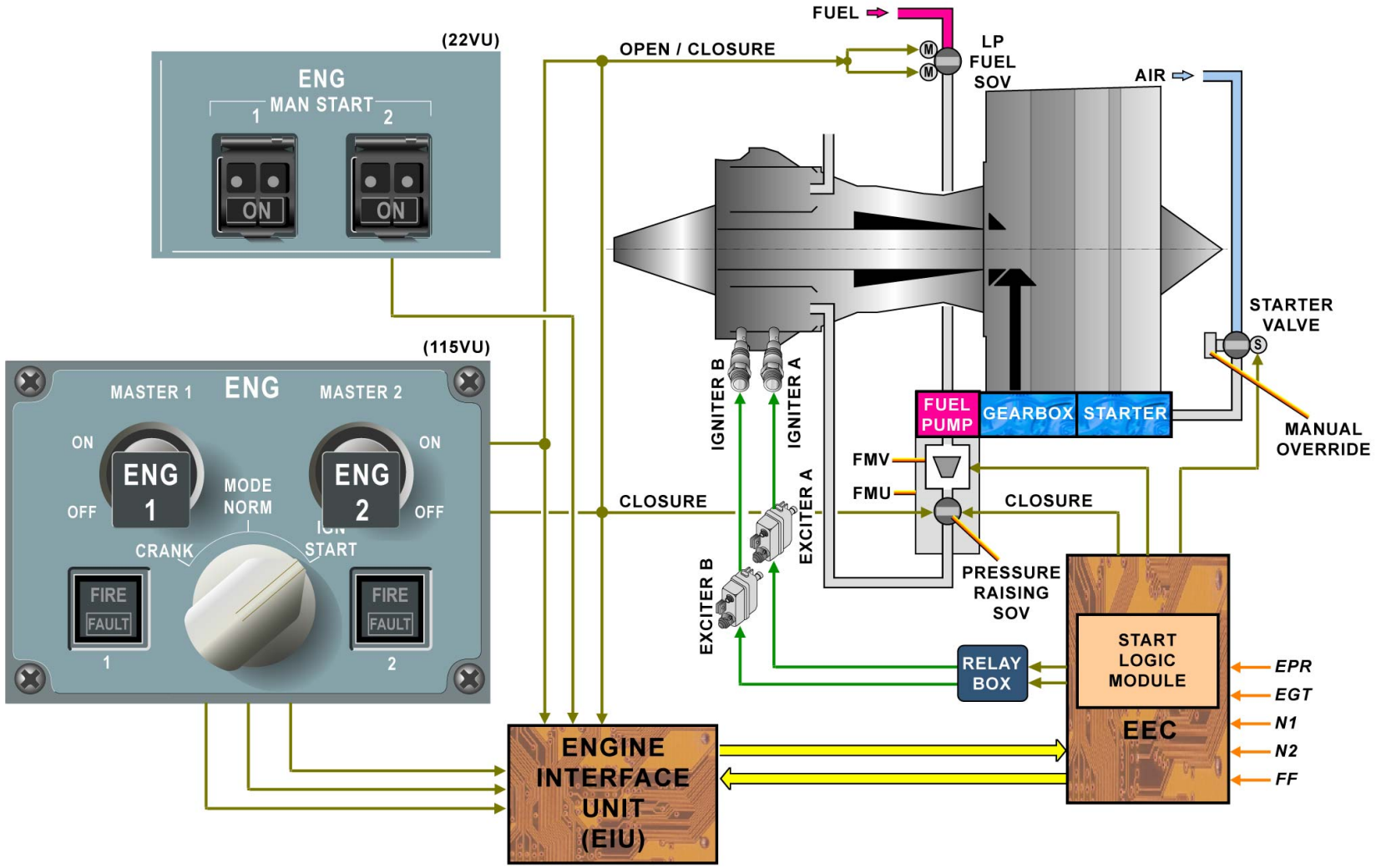
GENERAL

IGNITION & STARTING SYSTEM D/O (3)

AUTO START

In aircraft configuration, the APU is running and APU bleed air is available. When the MODE selector is set to IGNition START, the EEC is armed for the start sequence. After checking indications and obtaining Ground Clearance, set the ENG/MASTER control switch to ON.

UGB13131 - U64T2M0 - UM74D1IAE000003


(22VU)
ENG
MAN START
1
2
ON
ON
(115VU)
MASTER 1
ENG
MASTER 2
ON
ENG
1
OFF
MODE
NORM
ON
ENG
2
OFF
CRANK
START
FIRE
FAULT
1
FIRE
FAULT
2
FUEL
OPEN / CLOSURE
LP
FUEL
SOV
AIR
STARTER
VALVE
MANUAL
OVERRIDE
IGNITER B
IGNITER A
FUEL
PUMP
GEARBOX
STARTER
FMV
FMU
CLOSURE
CLOSURE
EXCITER A
EXCITER B
PRESSURE
RAISING
SOV
START
LOGIC
MODULE
EEC
RELAY
BOX
EPR
EGT
N1
N2
FF
ENGINE
INTERFACE
UNIT
(EIU)

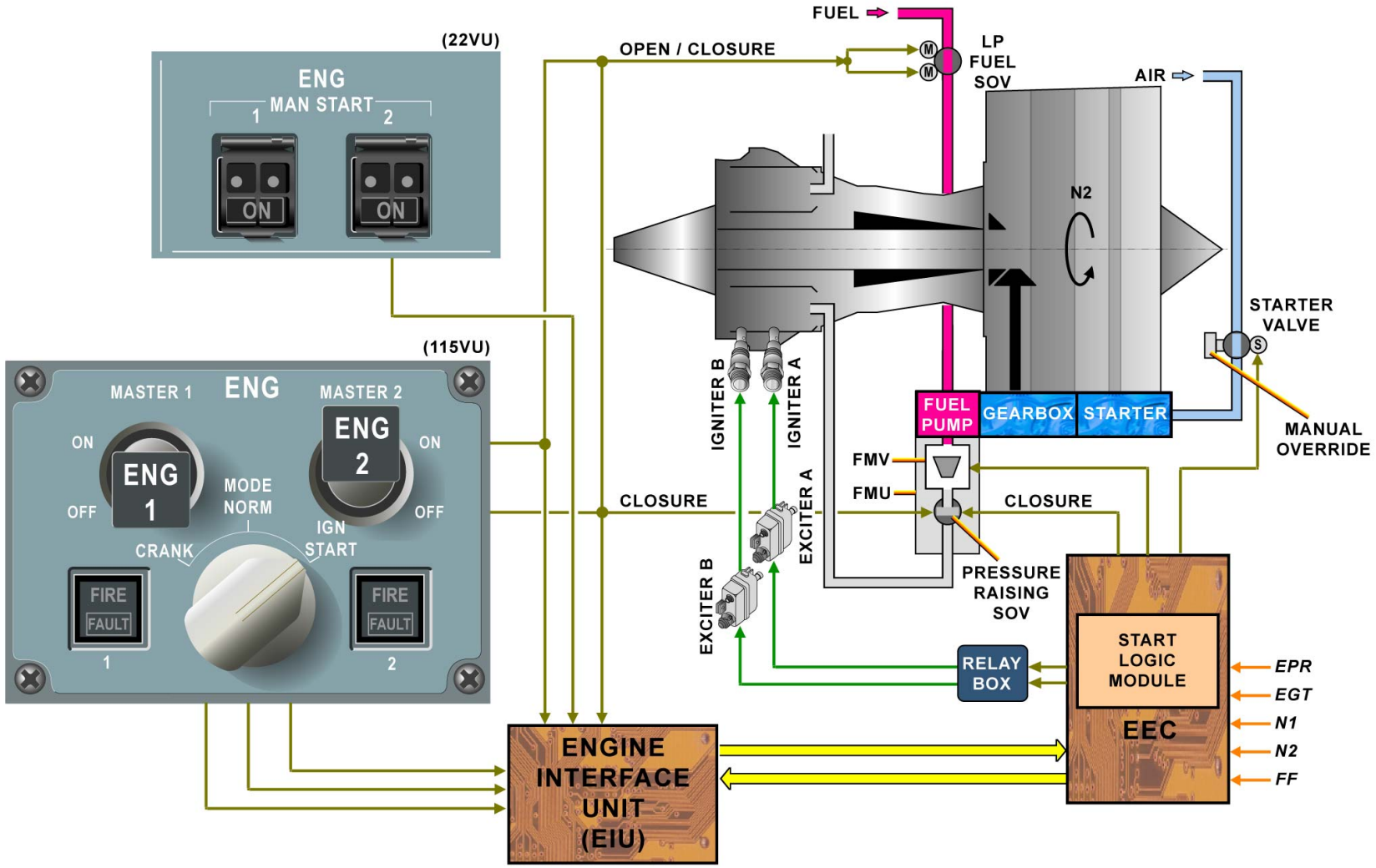
AUTO START

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

MASTER SWITCH ON

As soon as the MASTER switch is set to ON, the Low Pressure (LP) fuel SOV opens and the EEC opens the starter valve:
- N2 increases,
o the pressure raising and SOV solenoid is de-energized because the MASTER switch is ON.
o Then the EEC provides ignition, which is automatically selected by the EEC and displayed on the ECAM ENGINE page.



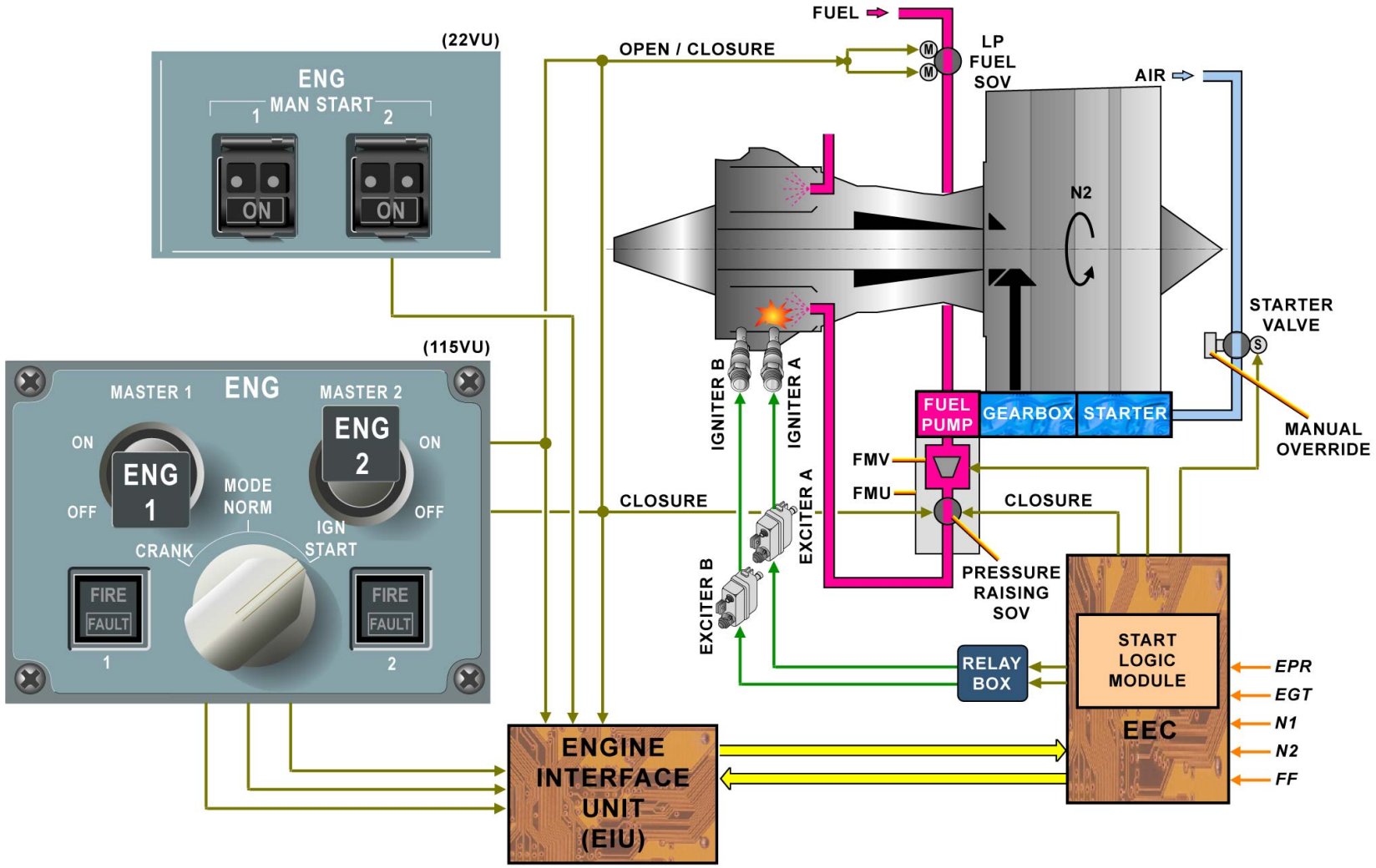
AUTO START - MASTER SWITCH ON

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

AFTER 30 SECONDS

After 30 seconds and together with the ignition, the EEC opens the Fuel Metering Valve (FMV) and the resulting fuel flow opens the pressure raising and SOV. In case of malfunction, the EEC automatically shuts down the engine and performs a dry motoring sequence.



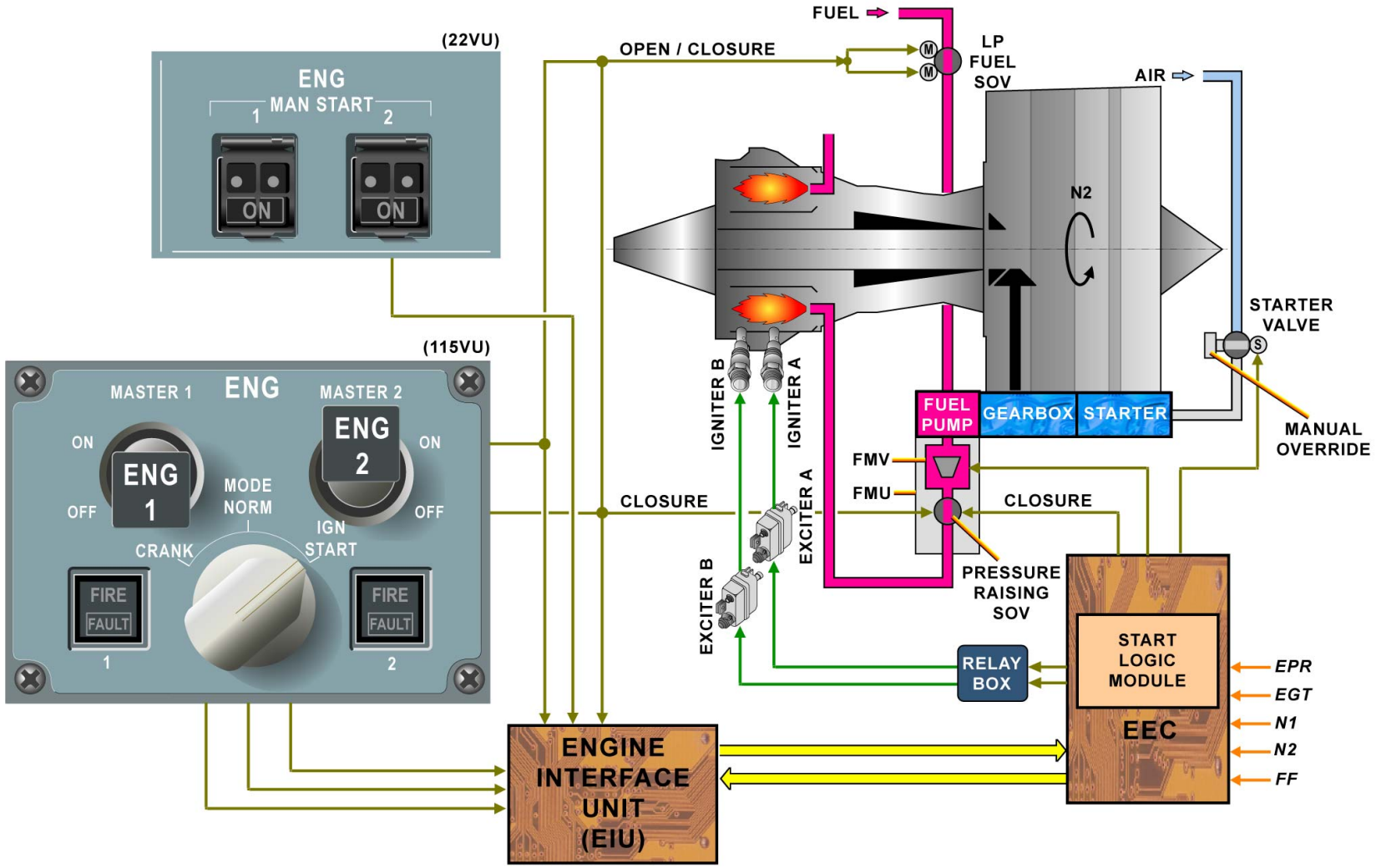
AUTO START - AFTER 30 SECONDS

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

N2 AT 43%

When N2 reaches 43%, the EEC closes the starter valve and cuts off the ignition.



AUTO START - N2 AT 43%

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

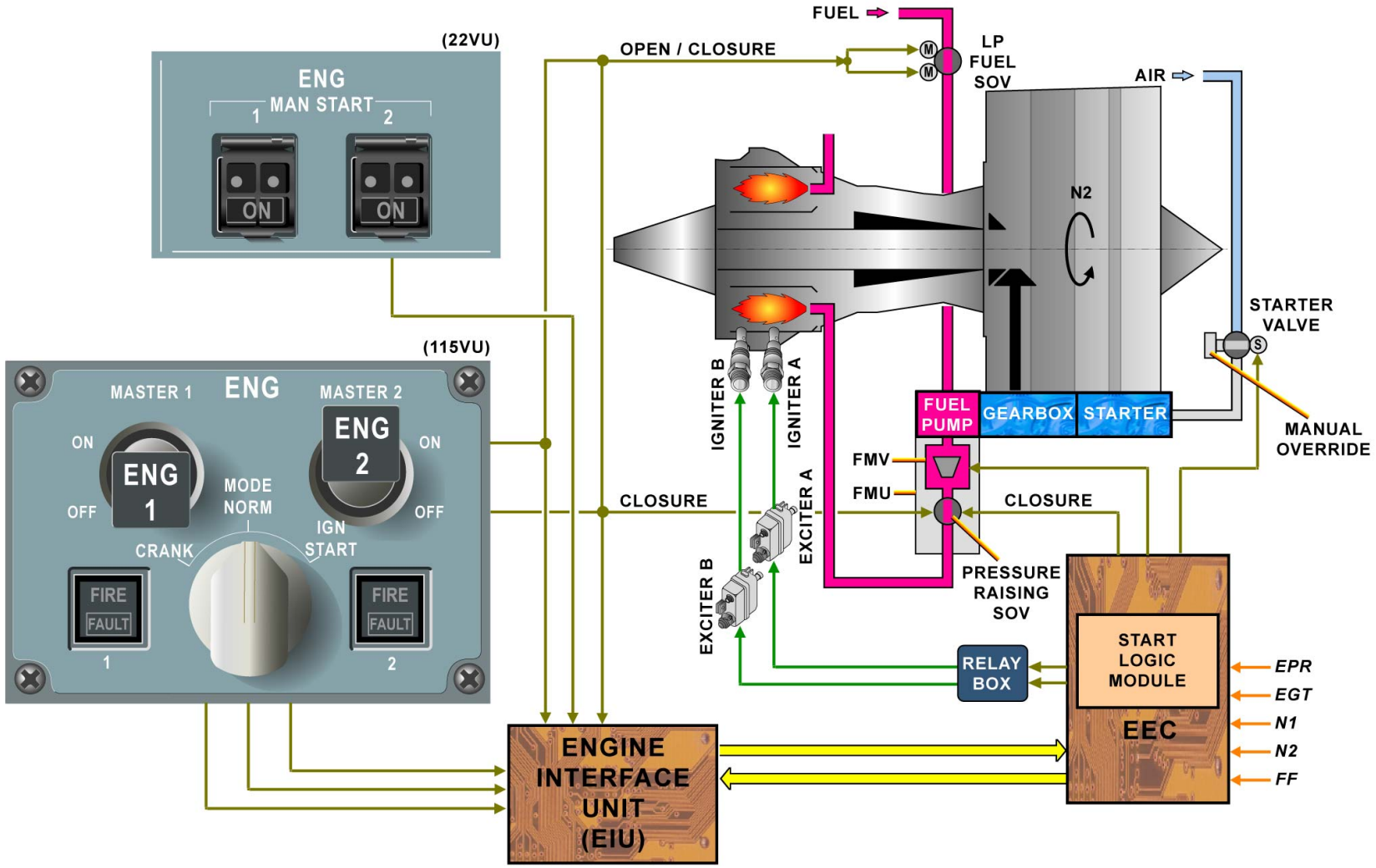
MODE SELECTOR SET TO NORM

Engine 2 is now stabilized at minimum idle.

NOTE: to start the second engine, you leave the MODE selector in the IGN START position, and set the MASTER lever 1 to ON.

After engine start the MODE selector is set to NORMal with the engine running.

WARNING: IF IGN START IS RESELECTED, THE CONTINUOUS RELIGHT FUNCTION IS INITIATED ON THE RUNNING ENGINE(S).



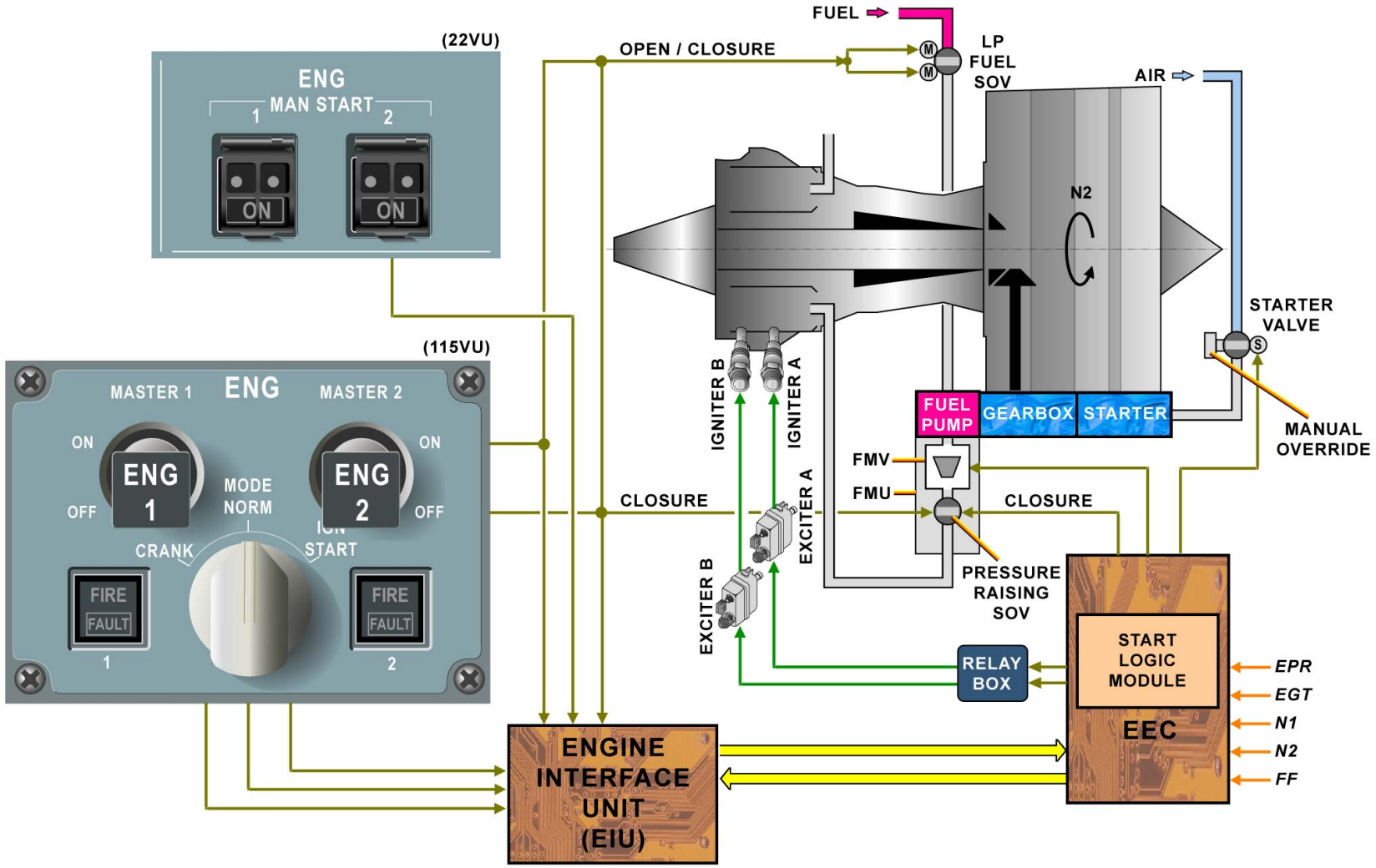
AUTO START - MODE SELECTOR SET TO NORM

IGNITION & STARTING SYSTEM D/O (3)

AUTO START (continued)

MASTER LEVER OFF

At any time, if the MASTER lever is set to OFF, the start sequence or engine operation is stopped because the MASTER lever directly energizes the pressure raising and SOV solenoid. With the MASTER lever to OFF, the LP and pressure raising SOVs close.



AUTO START - MASTER LEVER OFF

IGNITION & STARTING SYSTEM D/O (3)

MANUAL START

In aircraft configuration, the APU is running and APU bleed air is available. When the MODE selector is set to IGN START, the EEC is armed for the start sequence. Action on the ENG MANual START P/B opens the starter valve, via the EEC. After 30 seconds dry crank, set the ENG/MASTER control switch to ON.

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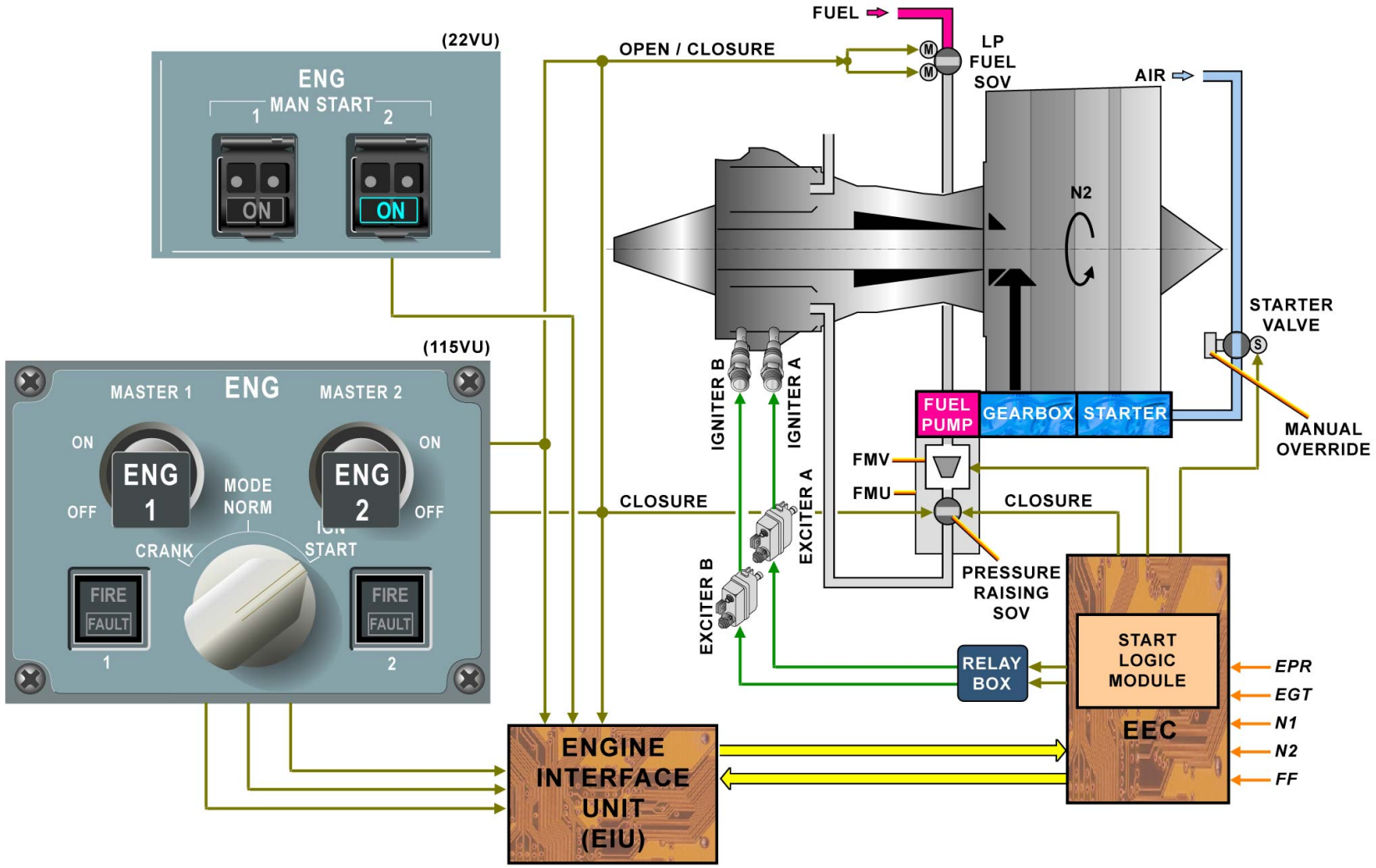


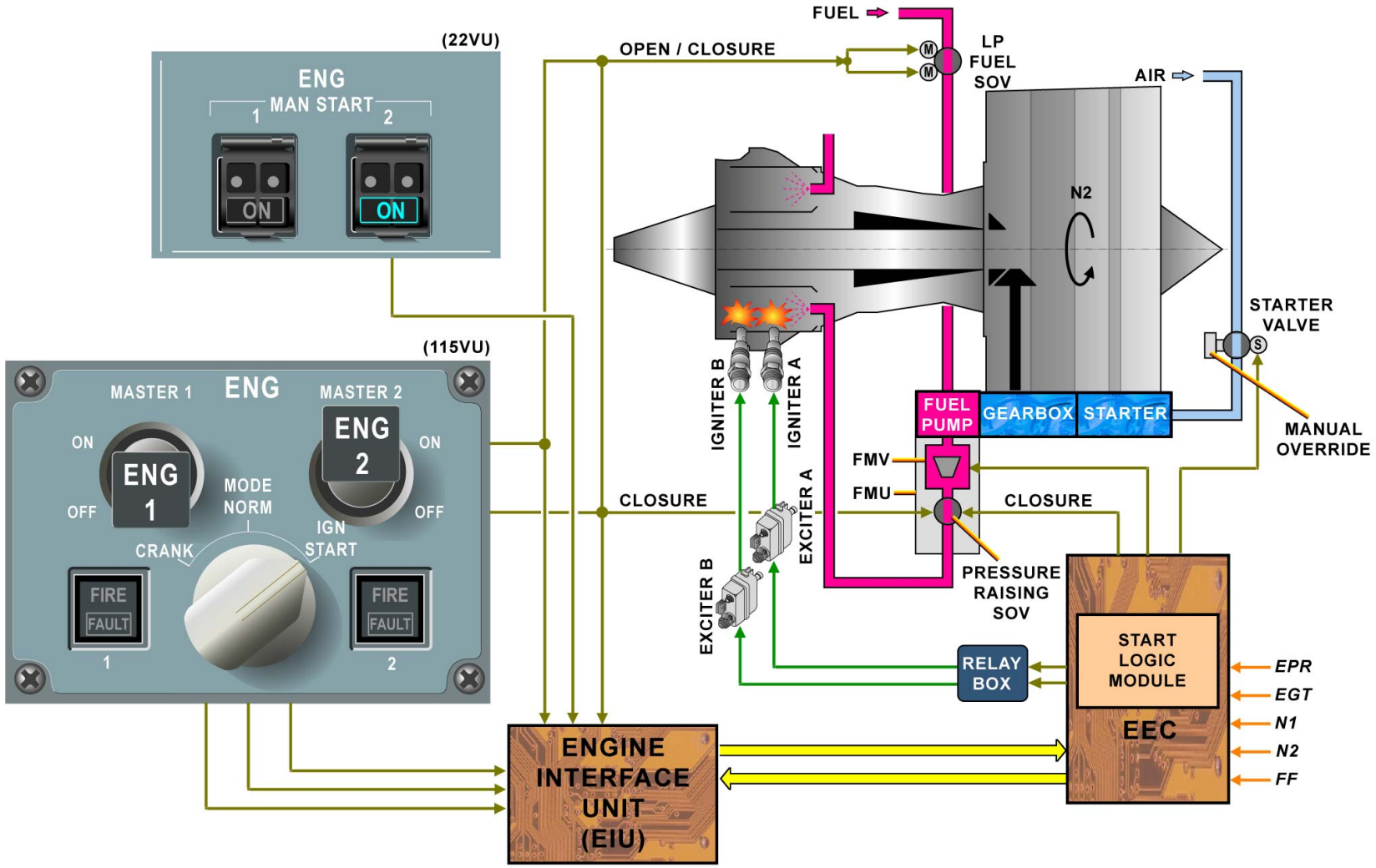
MANUAL START

IGNITION & STARTING SYSTEM D/O (3)

MANUAL START (continued)

AFTER 30 SECONDS

As soon as the MASTER lever is in the ON position, both ignition systems are energized, LP and pressure raising SOVs open and the fuel flow increases. A dual ignition and a fuel flow start. The MAN START P/B stays latched and is normally left alone during the start sequence.



MANUAL START - AFTER 30 SECONDS

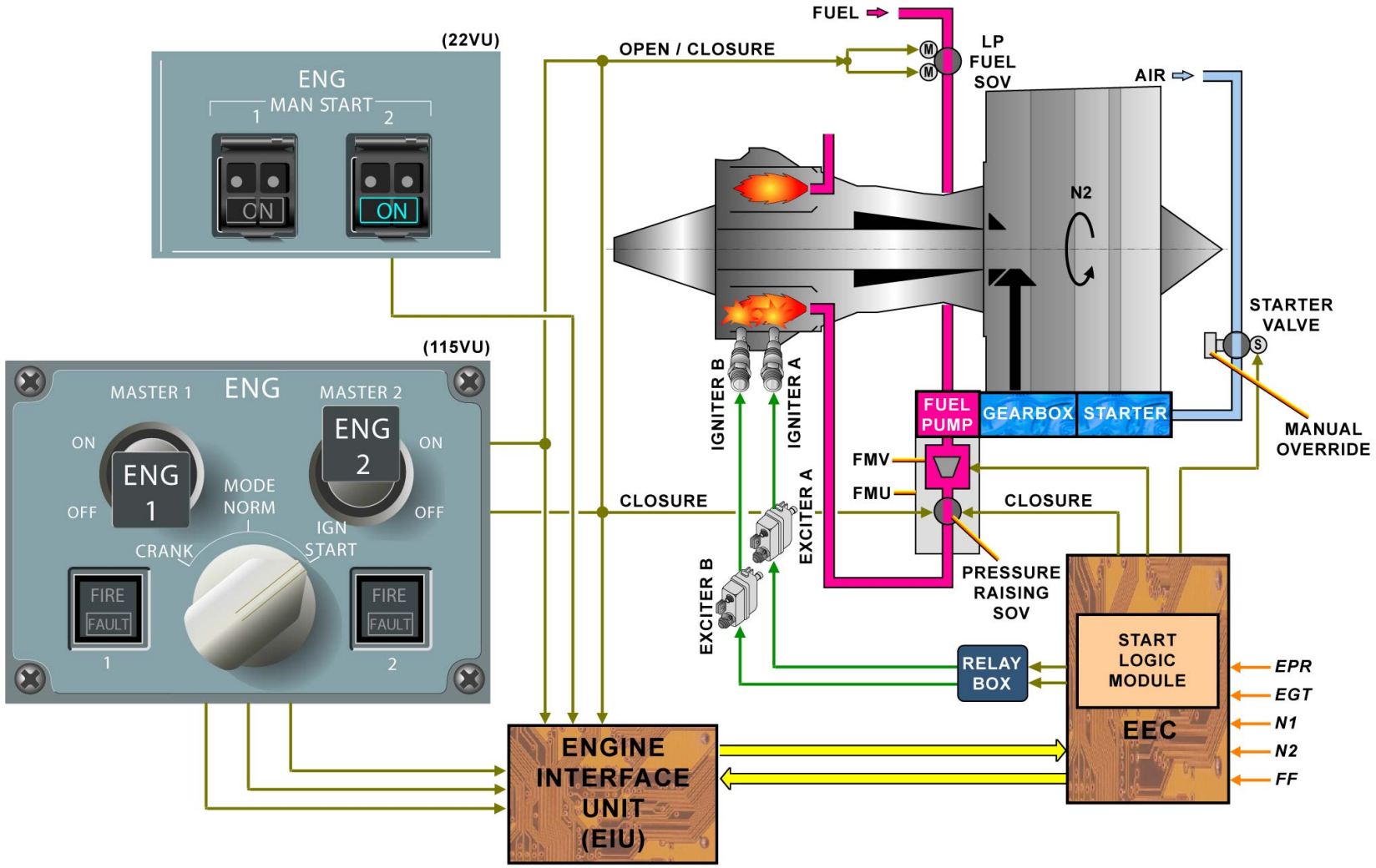
IGNITION & STARTING SYSTEM D/O (3)

MANUAL START (continued)

EGT INCREASING

Action on the MAN START P/B has no effect on the start sequence as long as the MASTER lever is set in the ON position. The MAN START P/B is normally released at the end when the engine parameters are stabilized. In case of malfunction, set the MASTER lever in the OFF position to abort the start. Start for up to 2 minutes maximum.

NOTE: there is no automatic shutdown function in manual start.



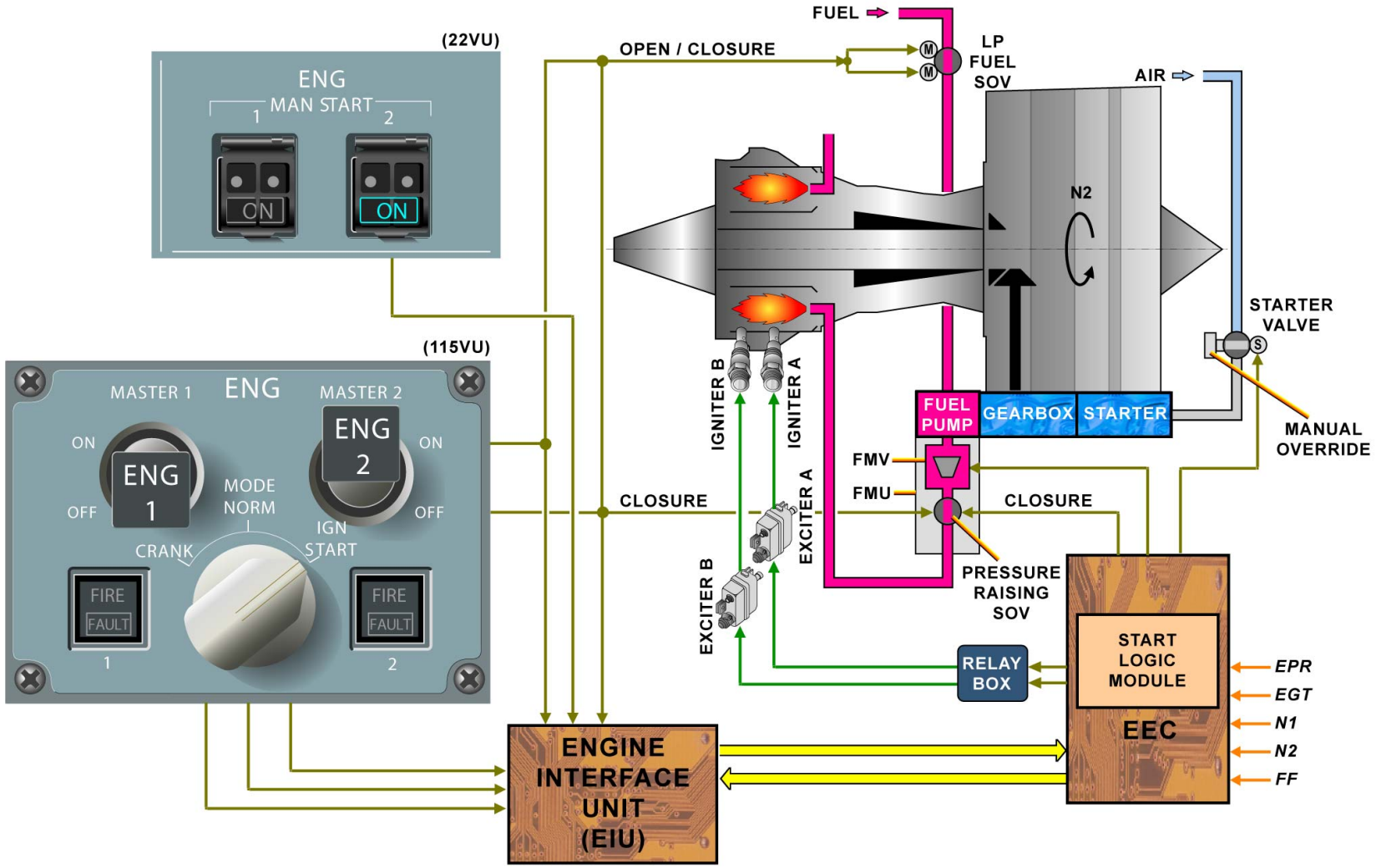
MANUAL START - EGT INCREASING

IGNITION & STARTING SYSTEM D/O (3)

MANUAL START (continued)

N2 AT 43%

When N2 reaches 43%, the EEC closes the starter valve and cuts off the ignition.



MANUAL START - N2 AT 43%

IGNITION & STARTING SYSTEM D/O (3)

MANUAL START (continued)

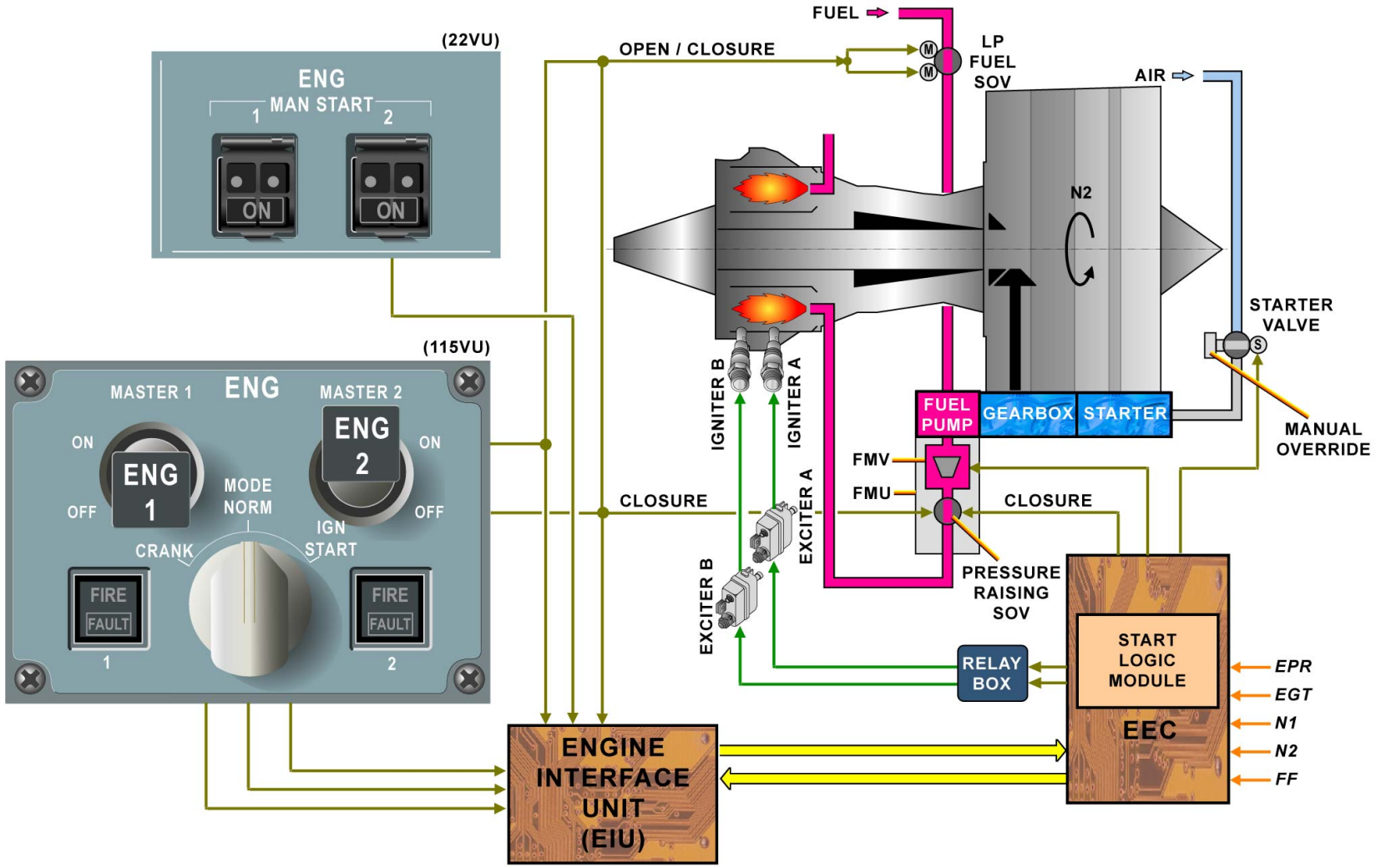
MODE SELECTOR SET TO NORM

Engine 2 is now stabilized at minimum idle.

NOTE: to start the second engine, you leave the MODE selector in the IGN START position, and set the MAN START P/B to ON, and after 30 seconds dry crank set the MASTER lever to ON.

After engine start the MODE selector is set to NORM with the engine running.

WARNING: IF IGN START IS RESELECTED, THE CONTINUOUS RELIGHT FUNCTION IS INITIATED ON THE RUNNING ENGINE(S).



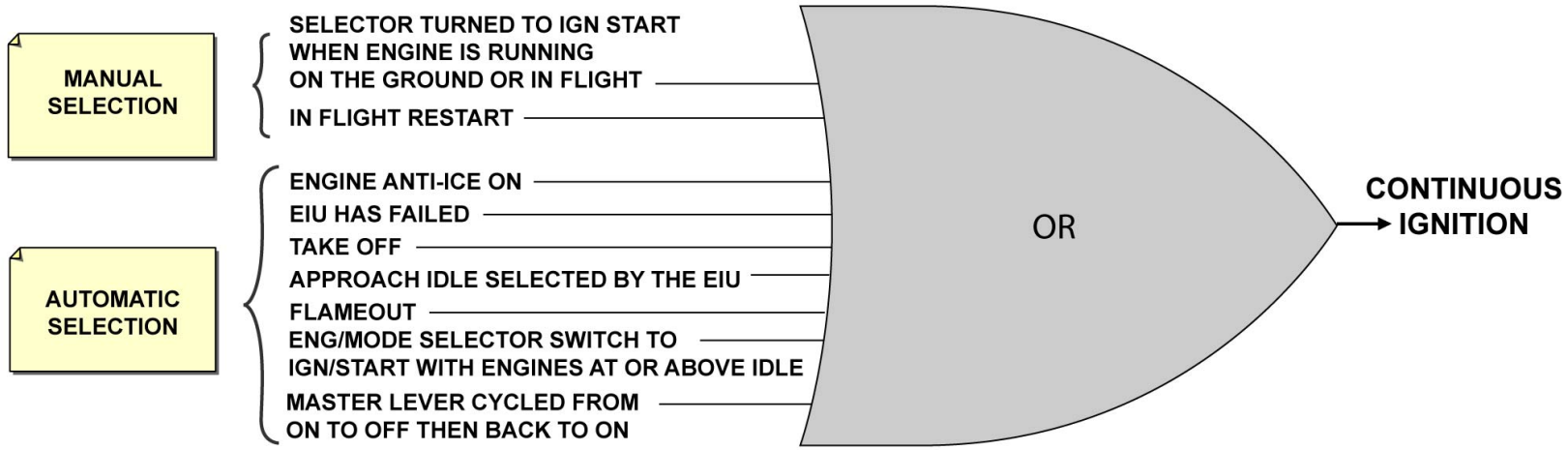
MANUAL START - MODE SELECTOR SET TO NORM

IGNITION & STARTING SYSTEM D/O (3)

CONTINUOUS RELIGHT

In aircraft configuration:
- the APU is running and APU bleed air is available,
- engine 2 is running.

The continuous ignition is manually selected or automatically controlled by the EEC according to the following logic.



CONTINUOUS RELIGHT

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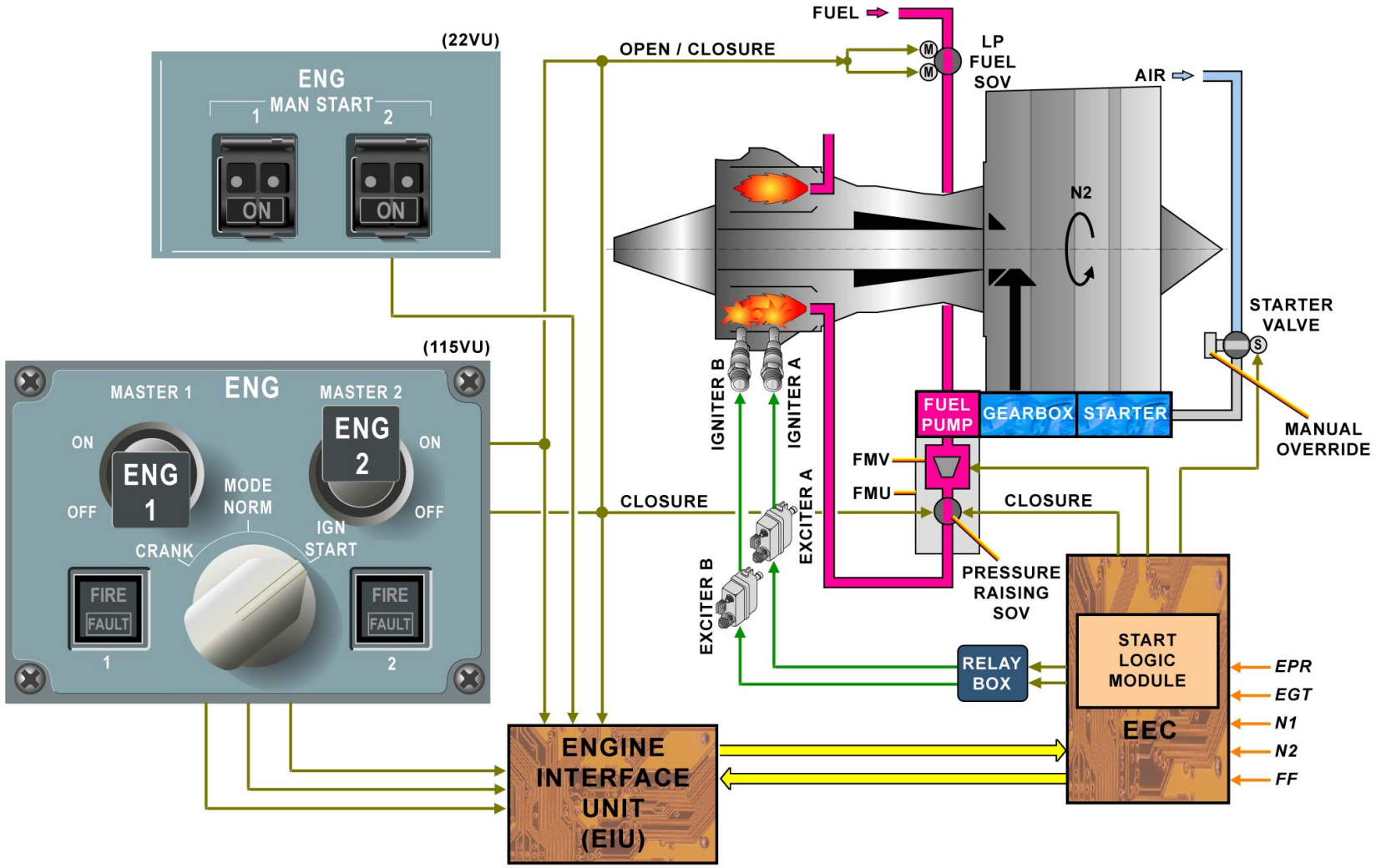
IGNITION & STARTING SYSTEM D/O (3)

CONTINUOUS RELIGHT (continued)

IGN START SELECTION

IF IGNition START is reselected with an engine running, the corresponding EEC supplies the 2 igniters together, to provide continuous ignition.



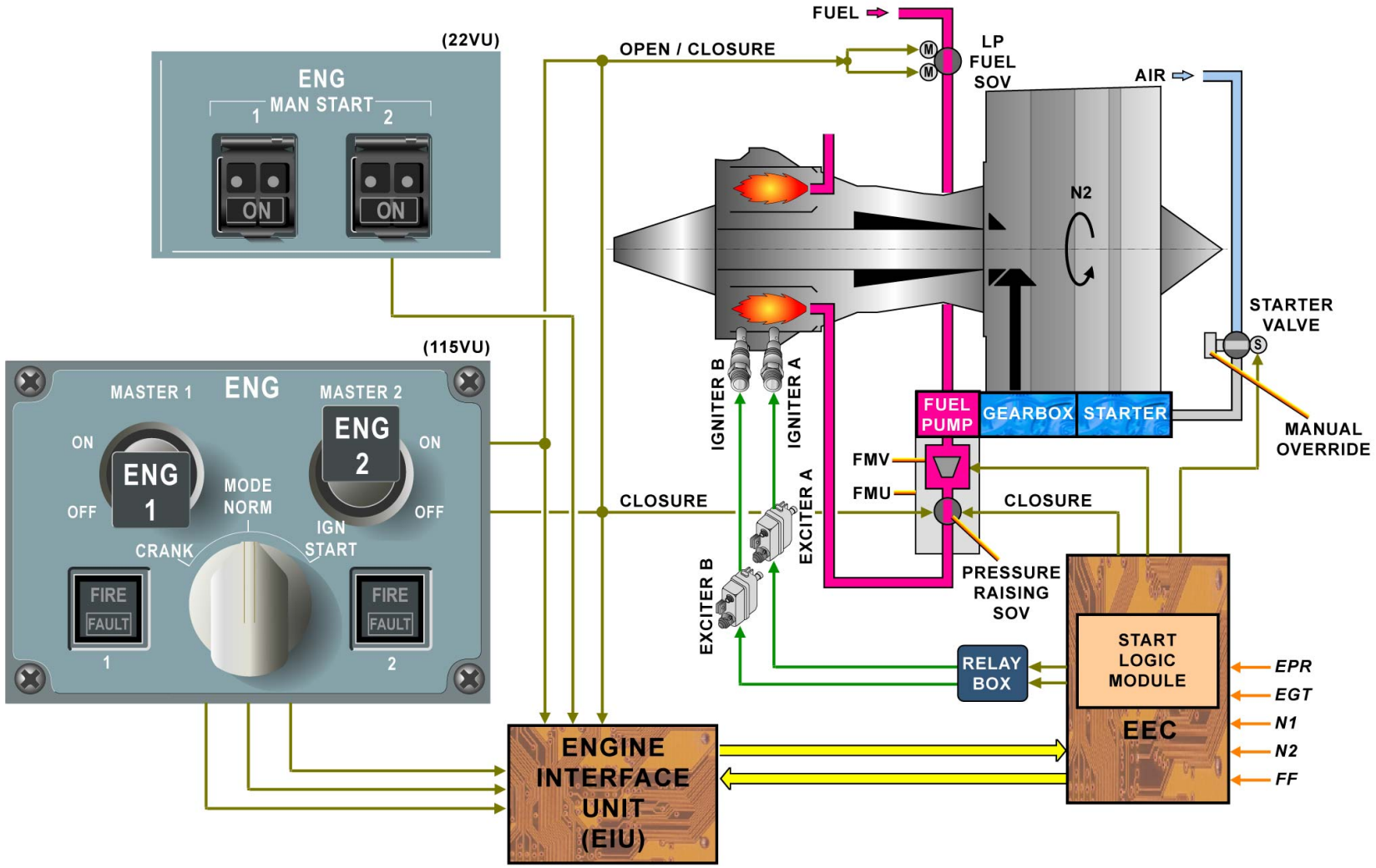
CONTINUOUS RELIGHT - IGN START SELECTION

IGNITION & STARTING SYSTEM D/O (3)

CONTINUOUS RELIGHT (continued)

NORM SELECTION

When NORM is restored, the continuous relight is cut off.



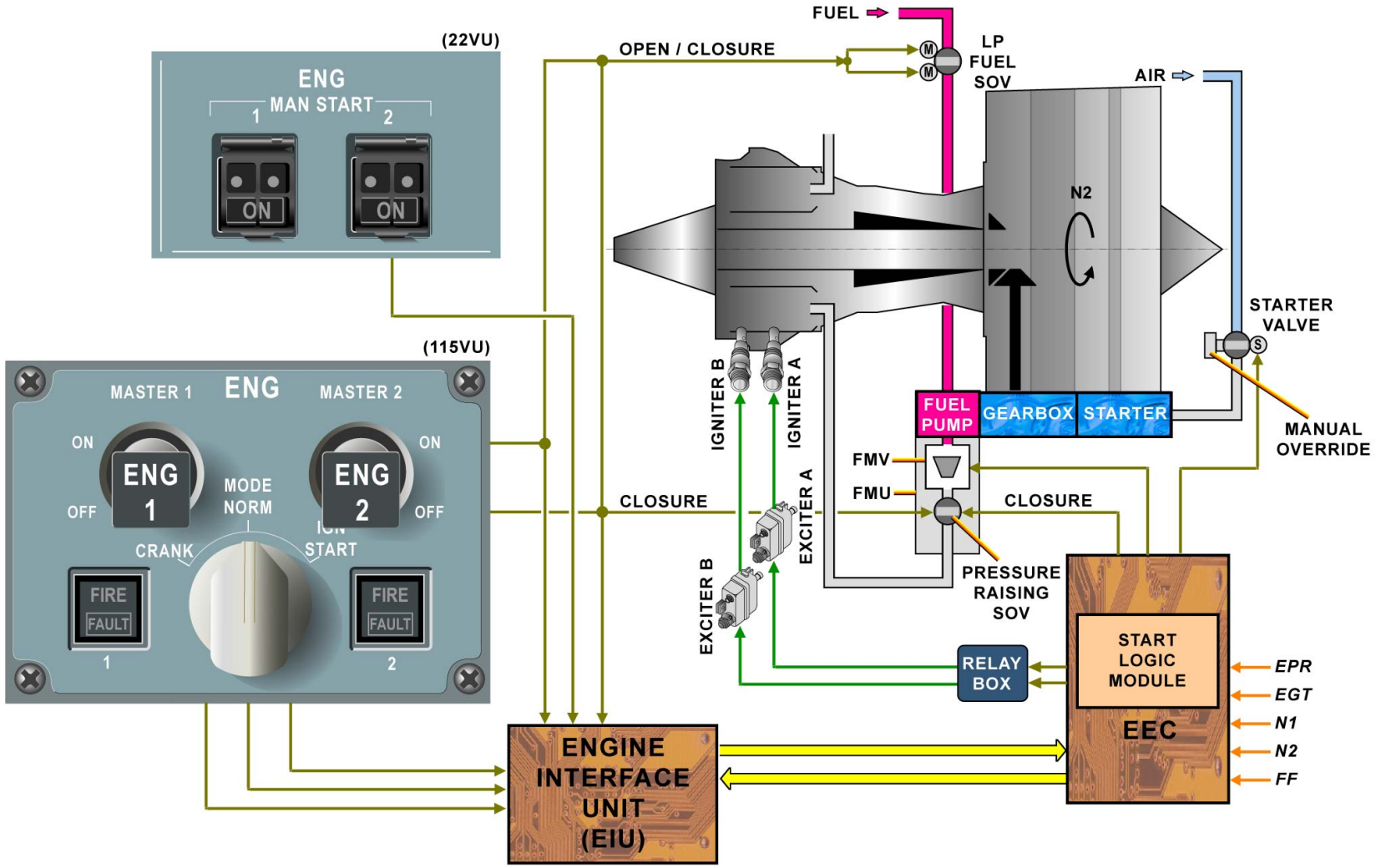
CONTINUOUS RELIGHT - NORM SELECTION

IGNITION & STARTING SYSTEM D/O (3)

CONTINUOUS RELIGHT (continued)

MASTER LEVER OFF

When the MASTER lever is set to OFF, the LP and pressure raising SOVs close and the EEC functions are reset. Engine 2 is shut down.



CONTINUOUS RELIGHT - MASTER LEVER OFF

IGNITION & STARTING SYSTEM D/O (3)

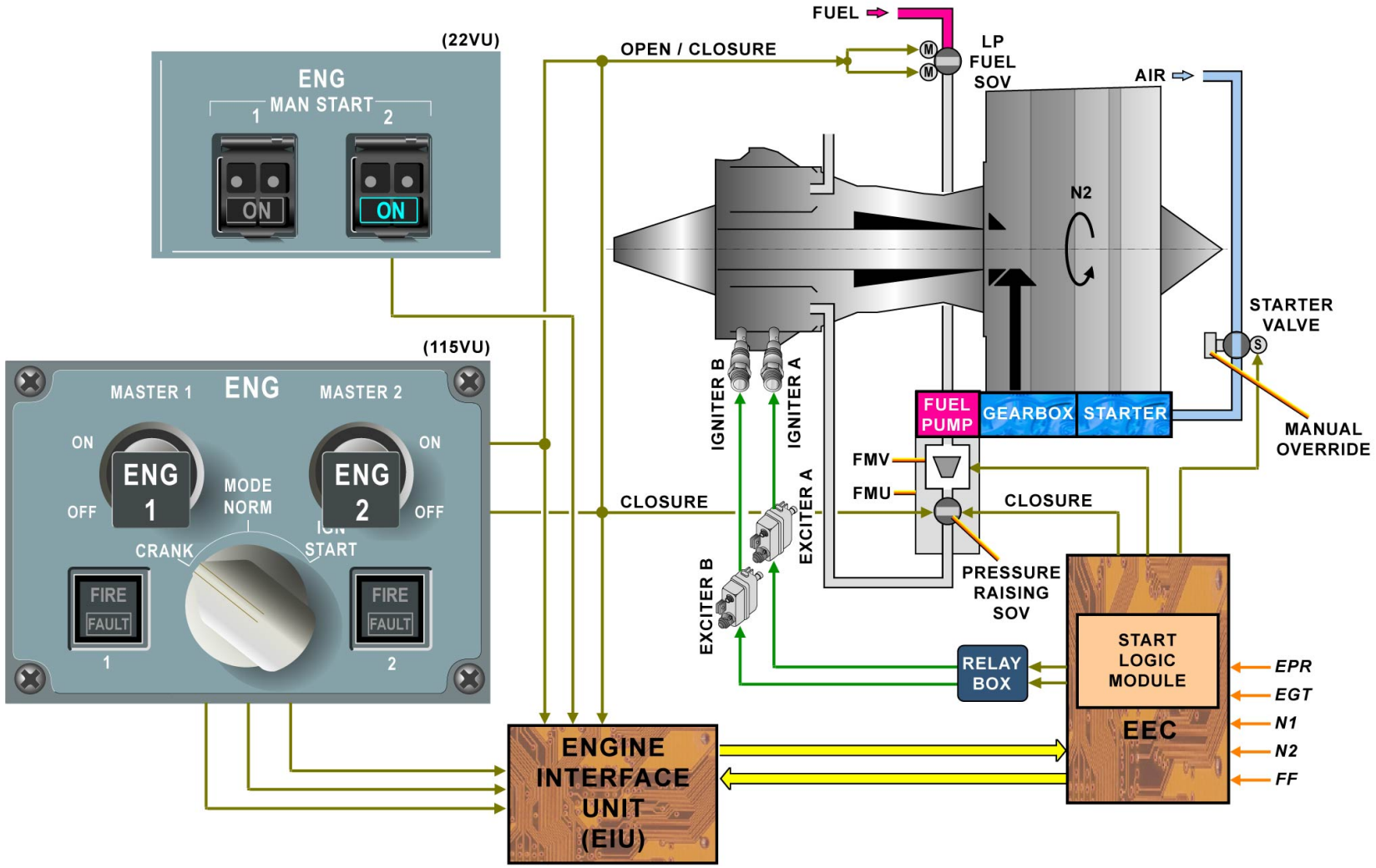
ENGINE DRY CRANK

In aircraft configuration:
- the APU is running and APU bleed air is available,
- both engines are shut down.

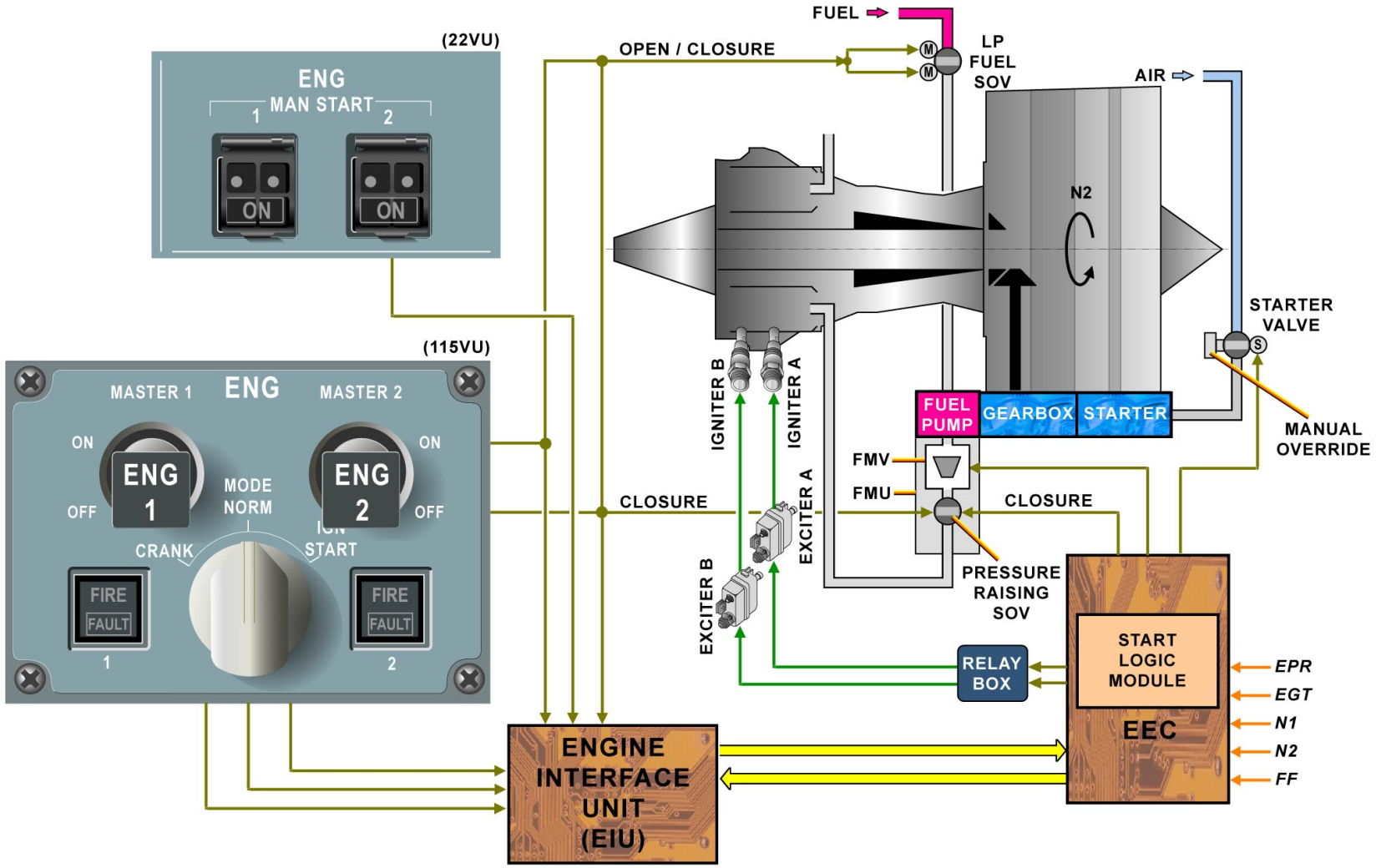
When CRANK is selected on the ground, the ignition is inhibited. Action on the ENG MAN START P/B provides opening of the starter valve via the EEC. During the crank sequence, the starter limitations should be observed. If the starter operation time is exceeded, a warning message is displayed on the ECAM, but there is no automatic abort.
The starter limitations when performing a dry crank are:
- a maximum of 3 consecutive cycles; 2 minutes on, 15 seconds off up 2 times and one minute on, then 30 minutes off for cooling,
- or 4 continuous minutes on, then 30 minutes off for cooling.

When the MAN START P/B is released out, the starter valve closes and the engine shuts down. To complete the crank sequence the MODE selector is set in the NORM position.

UGB13131 - U64T2M0 - UM74D1IAE000003



ENGINE DRY CRANK



ENGINE DRY CRANK

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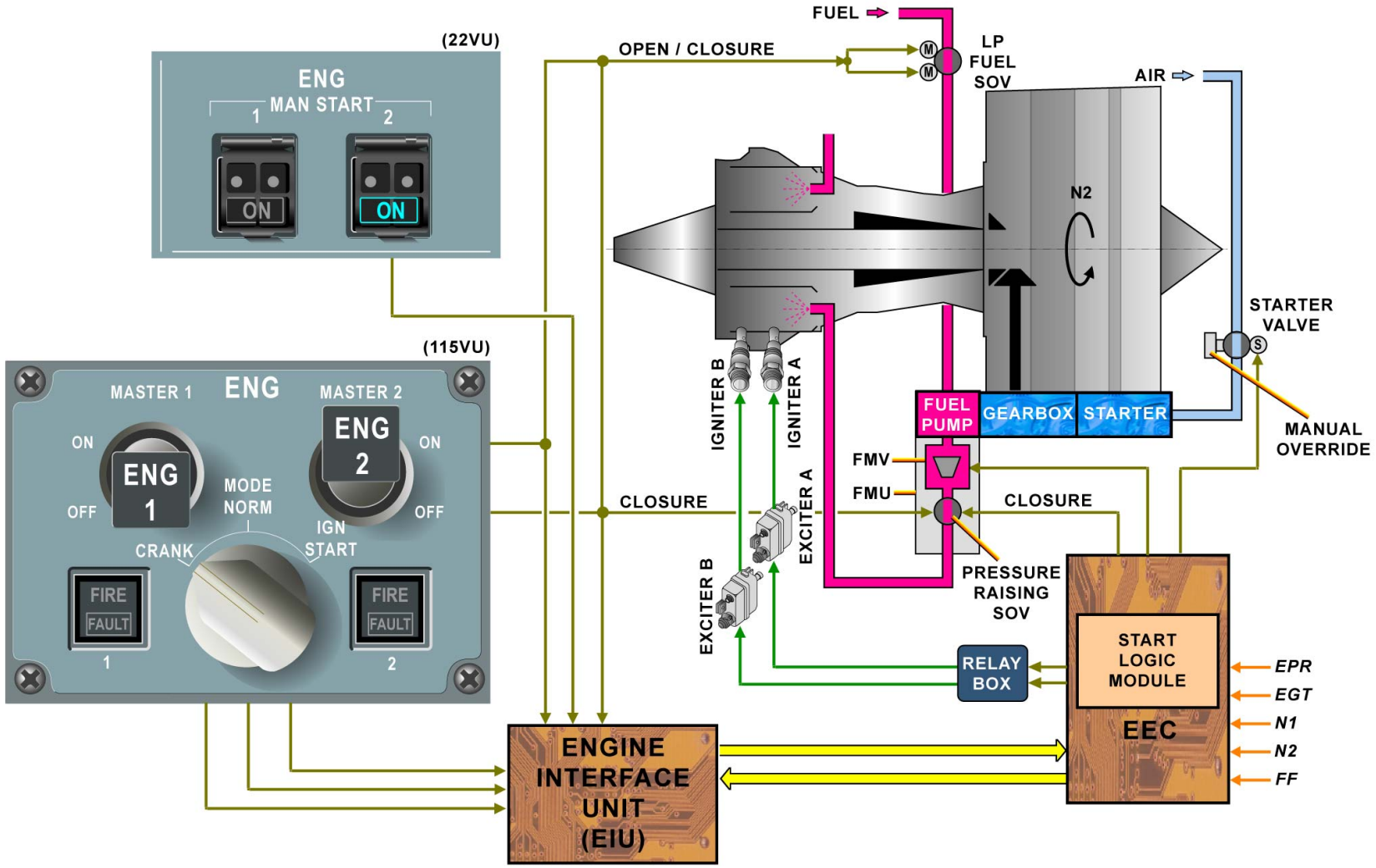
IGNITION & STARTING SYSTEM D/O (3)

ENGINE DRY CRANK (continued)

ENGINE WET CRANK-LEVER ON

To perform a wet crank, allow N2 to increase to 20% RPM before setting the MASTER lever to ON. When the MASTER lever is set in the ON position, the LP and pressure raising SOVs open.



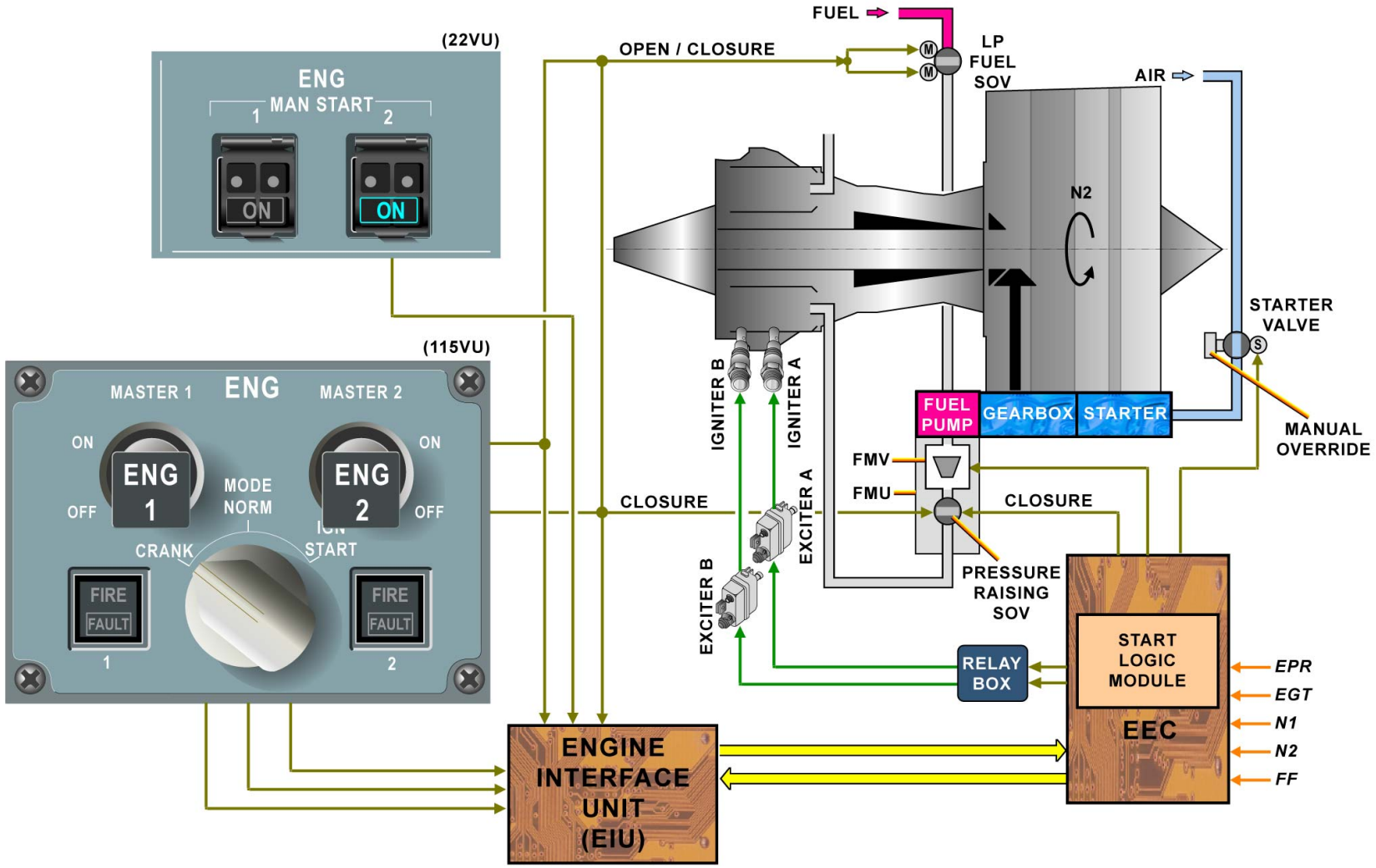
ENGINE DRY CRANK - ENGINE WET CRANK-LEVER ON

IGNITION & STARTING SYSTEM D/O (3)

ENGINE DRY CRANK (continued)

ENGINE WET CRANK-CRANK

After wet cranking, the MASTER lever must be set to OFF. The EEC closes the starter valve and reopens it automatically when the N2 is below 10% and dry cranking follows to eliminate fuel vapors from the engine. Continue to dry crank for a minimum of 60 seconds.



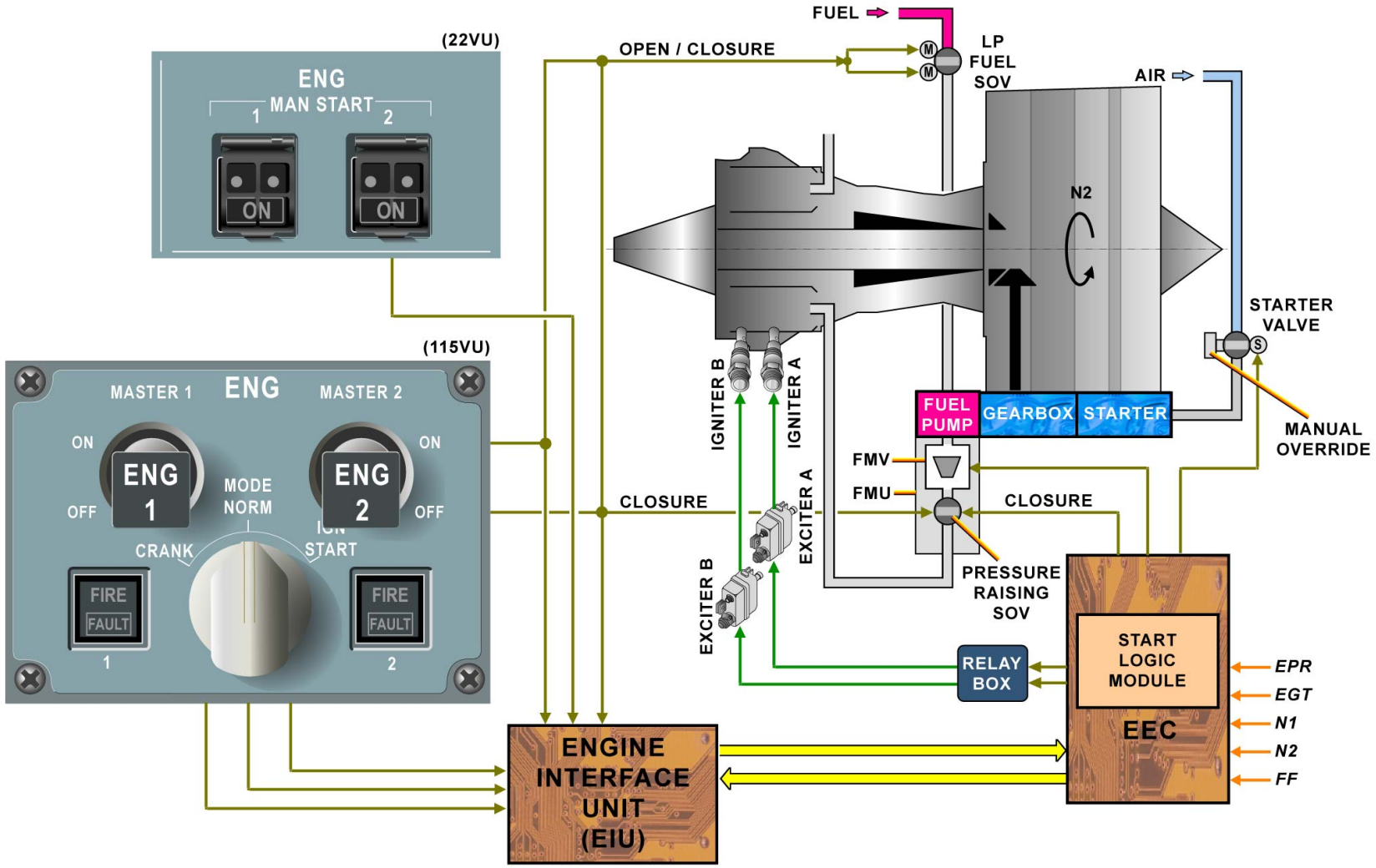
ENGINE DRY CRANK - ENGINE WET CRANK-CRANK

IGNITION & STARTING SYSTEM D/O (3)

ENGINE DRY CRANK (continued)

MODE SELECTOR SET TO NORM

When the MAN START P/B is released out, the starter valve closes and the engine shuts down. To complete the crank sequence the MODE selector is set in the NORM position.



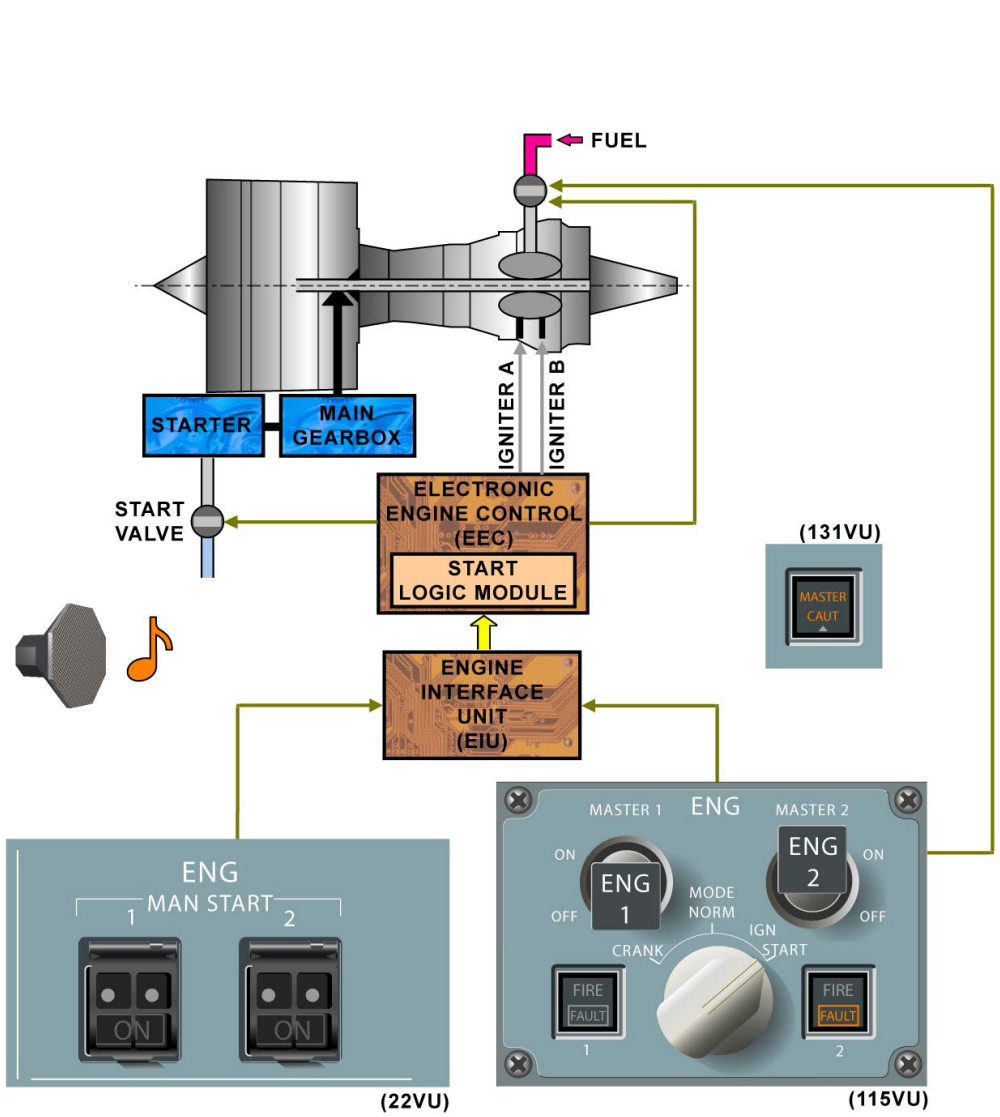
ENGINE DRY CRANK - MODE SELECTOR SET TO NORM

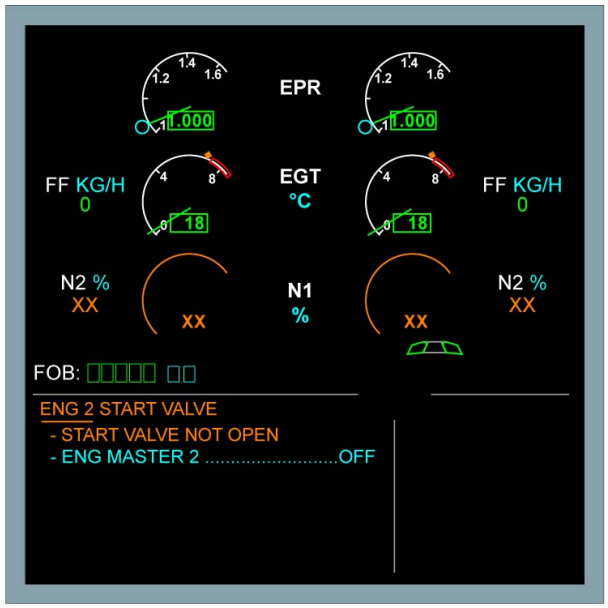
UGB13131 - U64T2M0 - UM74D11AE000003

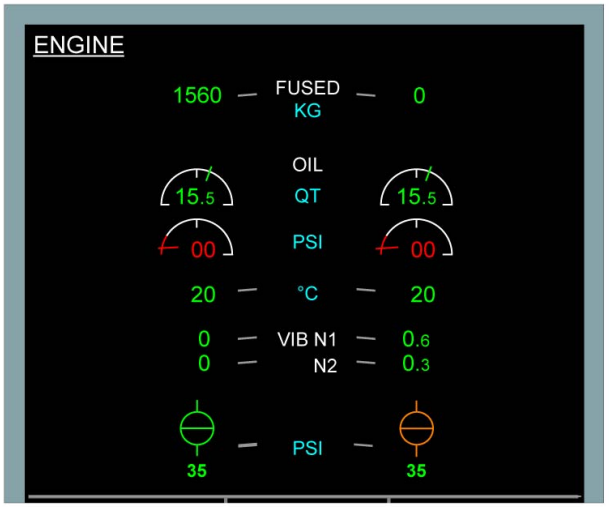
START FAILURES (ME) (3)

START VALVE (NOT OPEN)

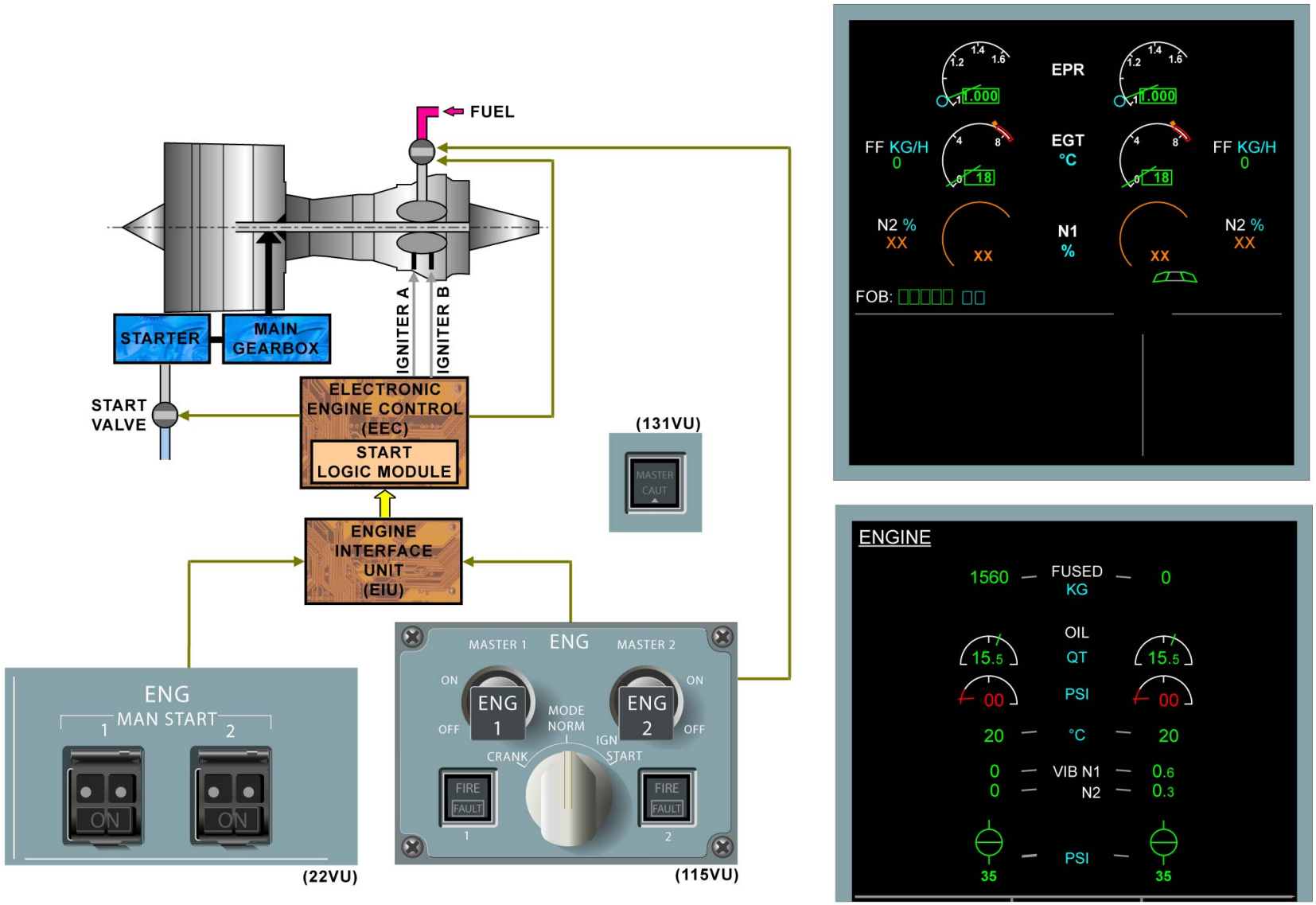
If the start valve does not open, an aural warning operates. The MASTER CAUTion and the ENGine FAULT lights come on. An ECAM message comes into view. The Full Authority Digital Engine Control (FADEC) aborts the start sequence.
Another start with a manual operation of the start valve is then done. For this, tell the ground crew to prepare for a start valve manual operation.
Make sure that if the opposite engine is in operation, the X BLEED P/B is ON, or if the APU is available, the APU BLEED P/B is ON.
Do an automatic start, set the MODE selector to IGNition.
When the MASTER lever is set to ON, tell the ground crew to open the start valve.
The start valve is opened.
When N2 is at 43%, tell the ground crew to close the start valve.
The start valve is closed, the engine is now in operation, continue with the normal procedure.



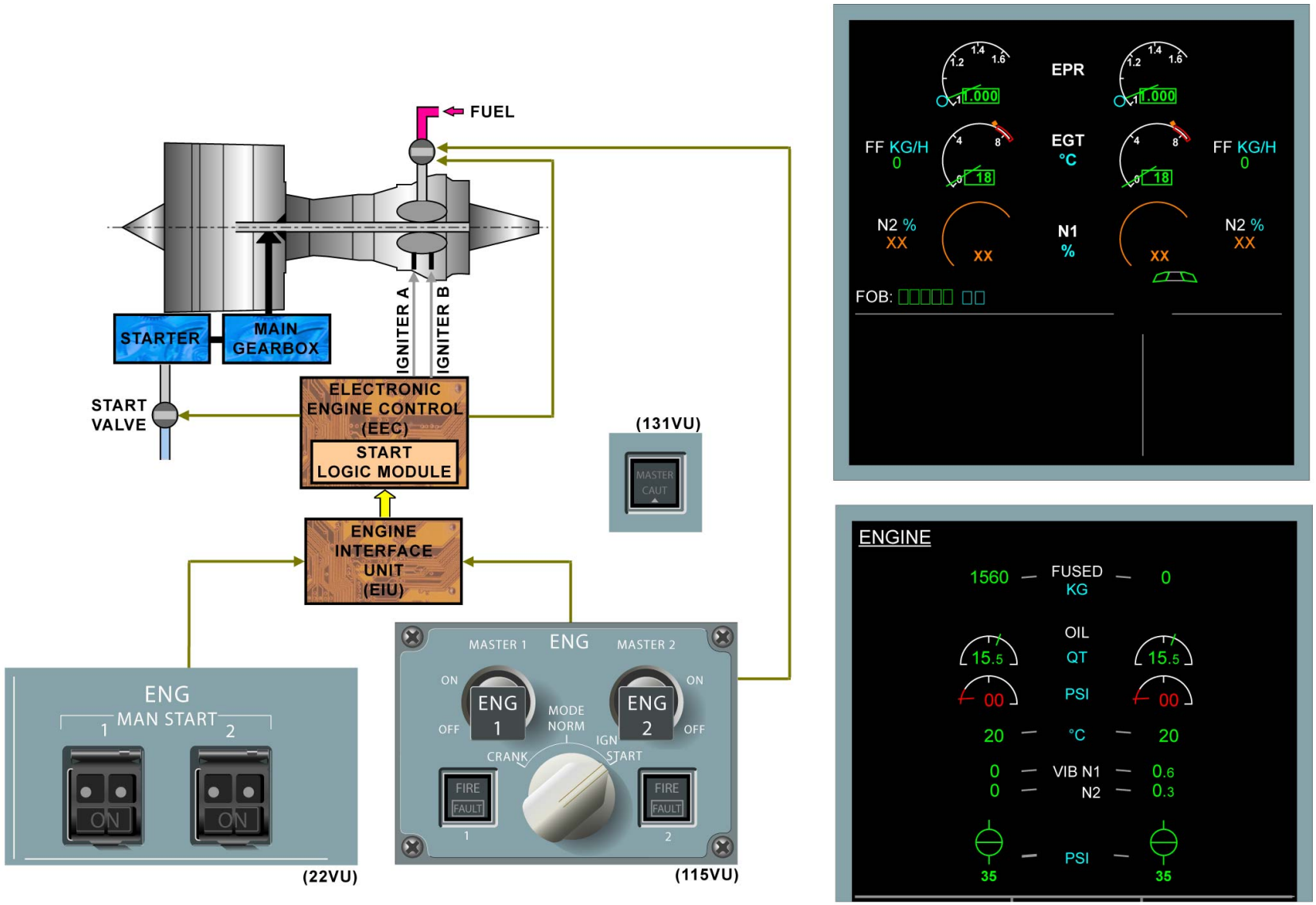




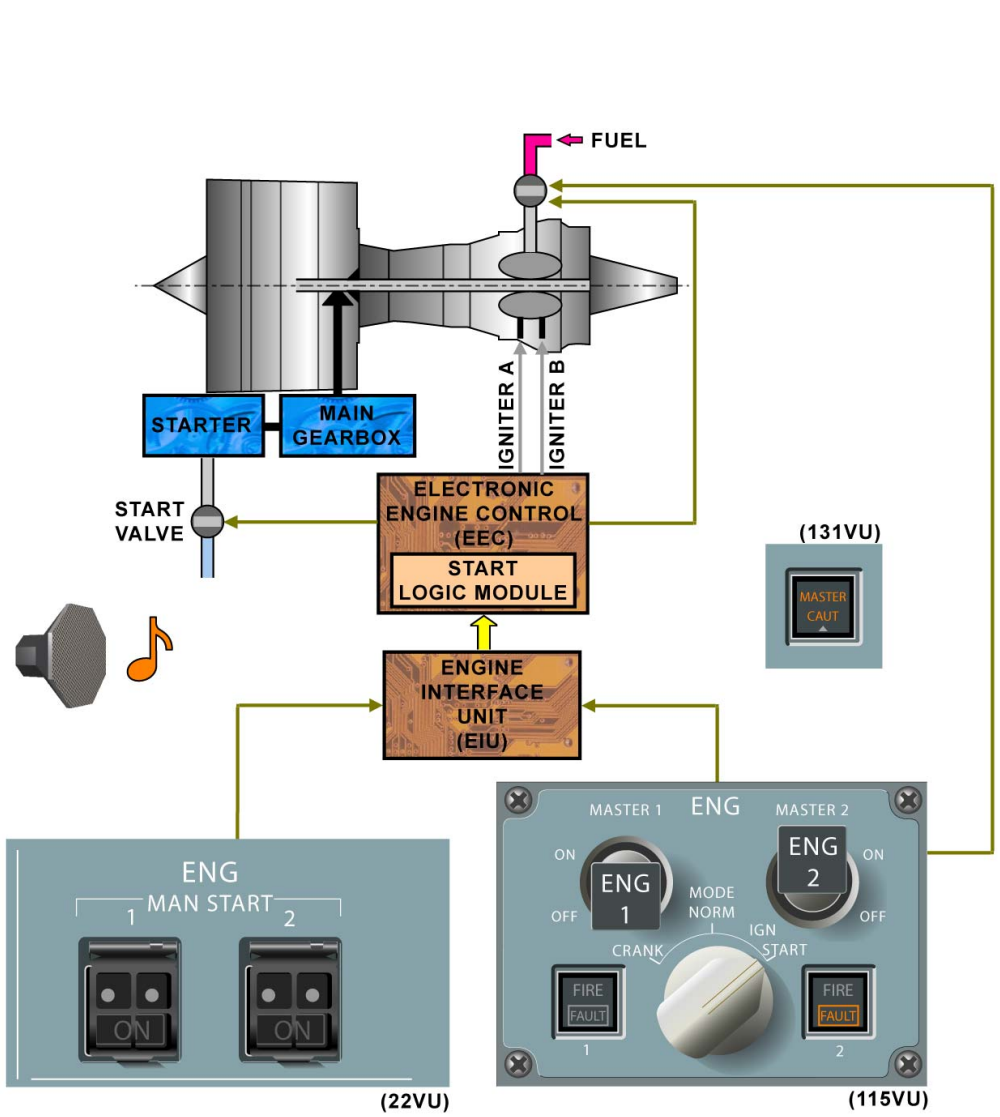
START VALVE (NOT OPEN)

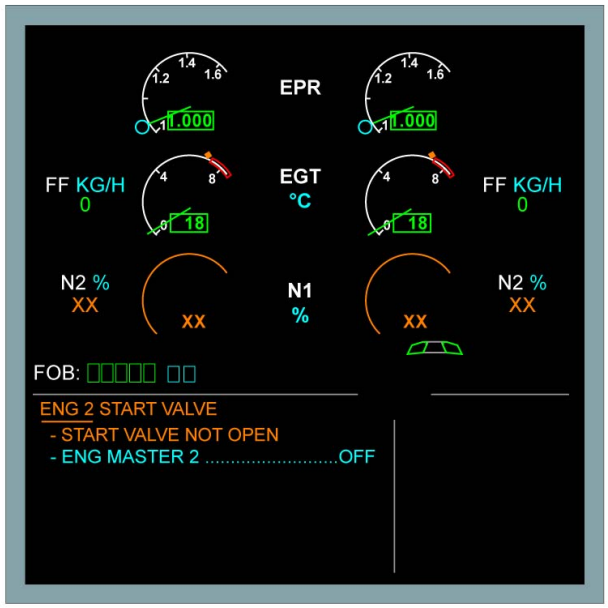


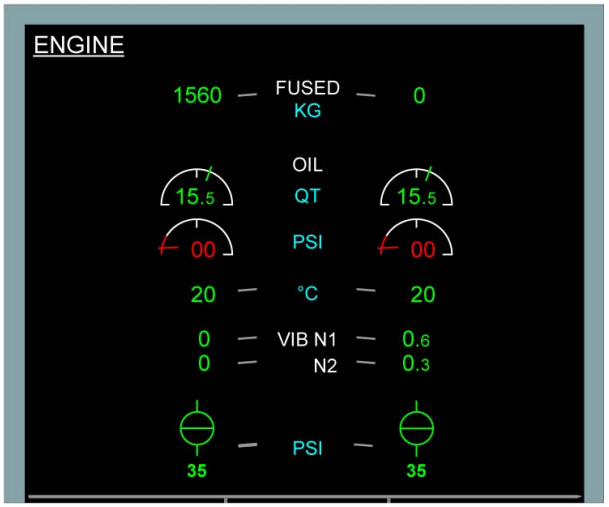
START VALVE (NOT OPEN)



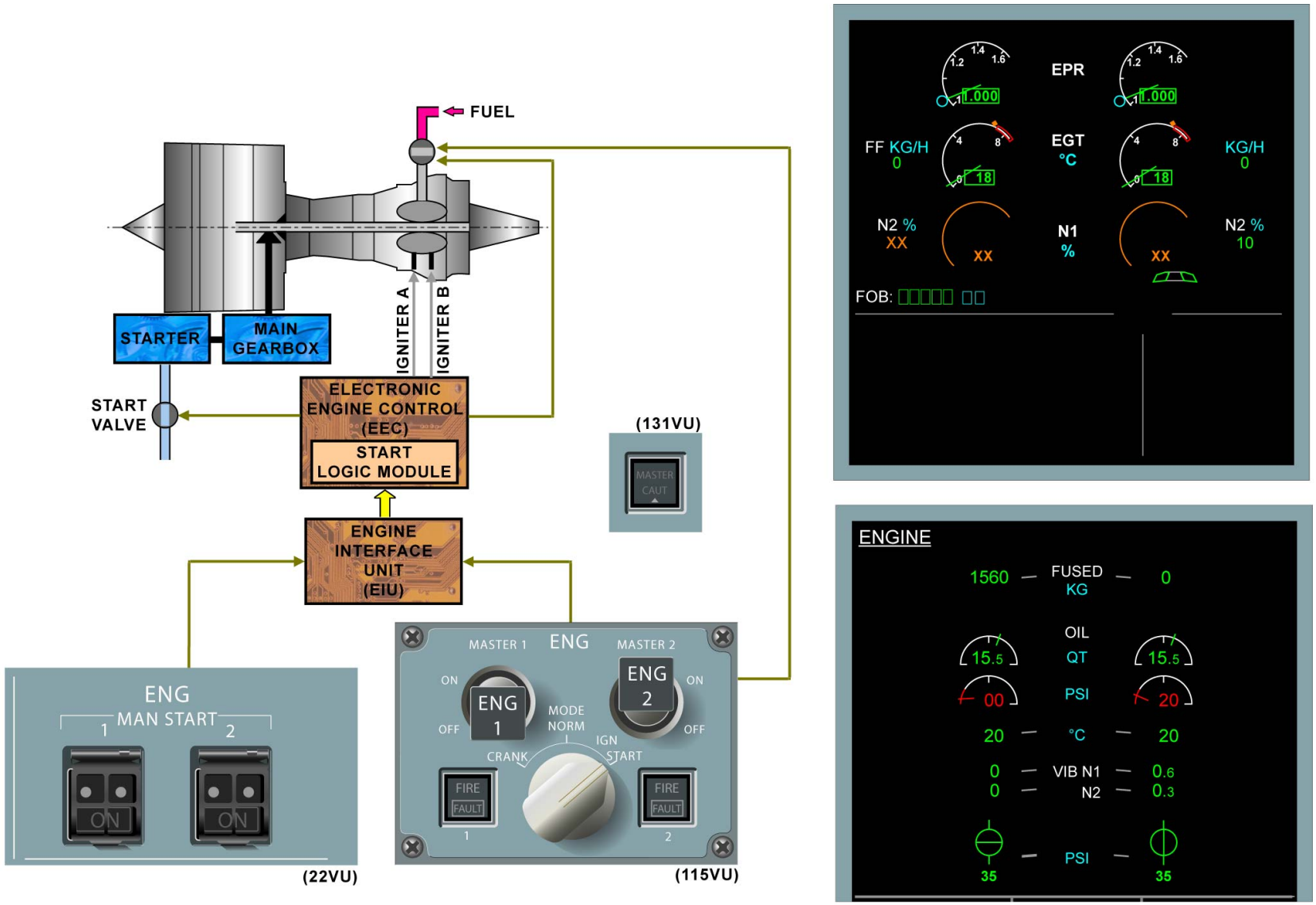
START VALVE (NOT OPEN)



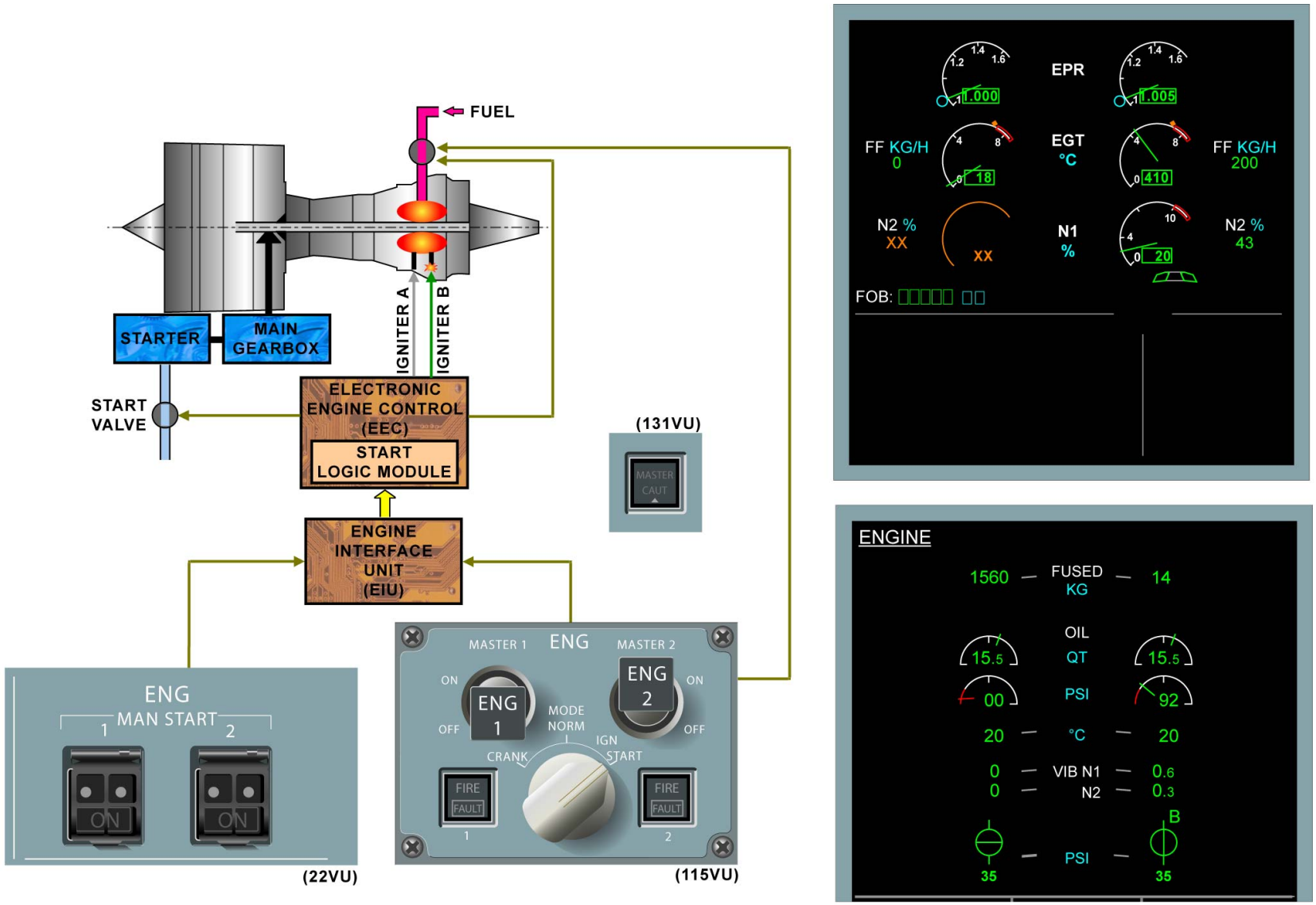




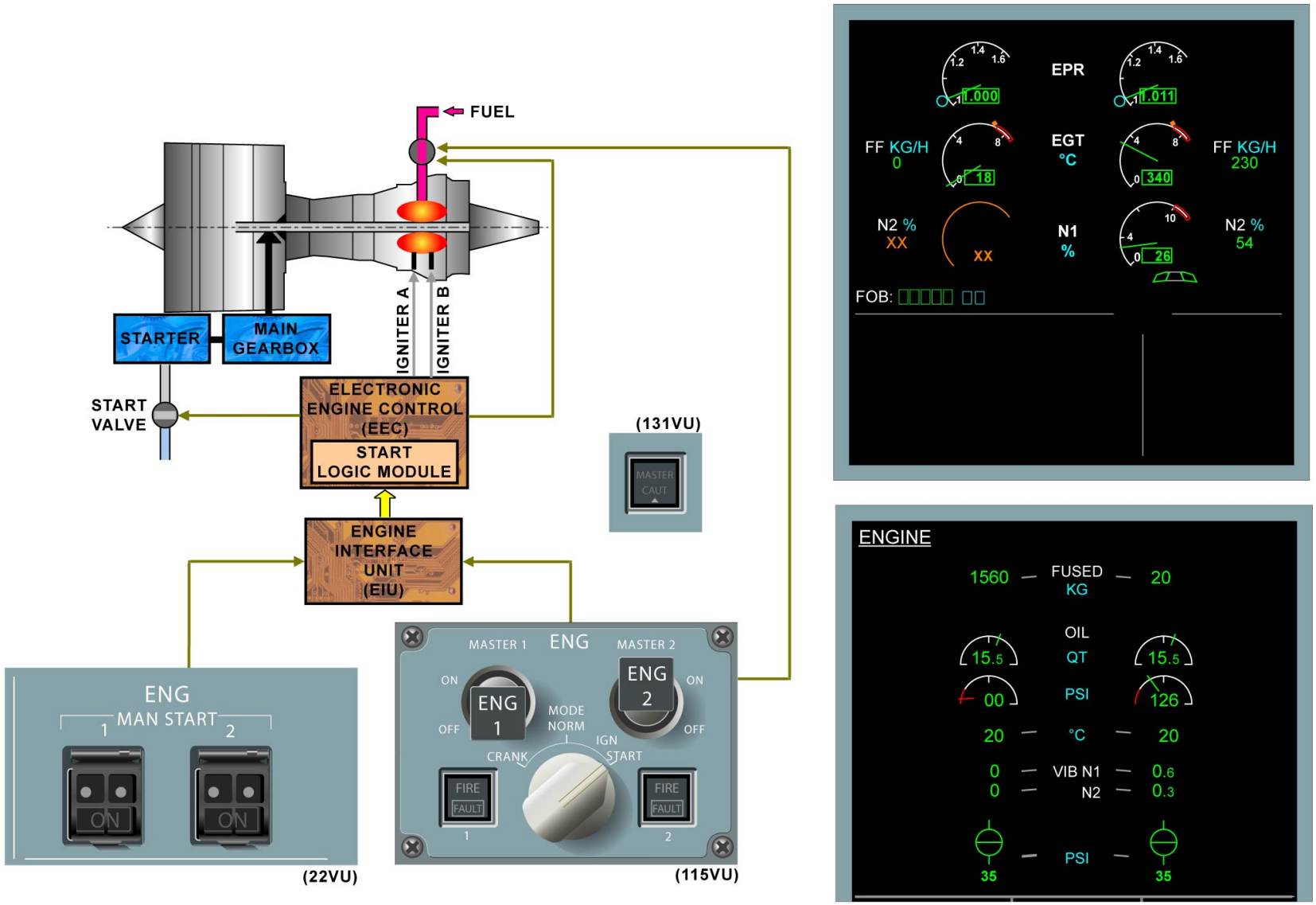
START VALVE (NOT OPEN)



START VALVE (NOT OPEN)



START VALVE (NOT OPEN)



START VALVE (NOT OPEN)

START FAILURES (ME) (3)

START VALVE (NOT CLOSED)

At 43% of N2, the FADEC sends a signal to close the start valve. If the start valve does not close, an aural warning operates. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. You must do the START VALVE NOT CLOSED procedure. For this, you must remove all bleed sources that supply the faulty start valve. Set the APU BLEED P/B (if engine 1 is in use) to OFF.
Set the X BLEED selector to SHUT.
Set the MASTER lever to OFF, then set the MODE selector to NORM.
Restart is not permitted, and a maintenance procedure is necessary.

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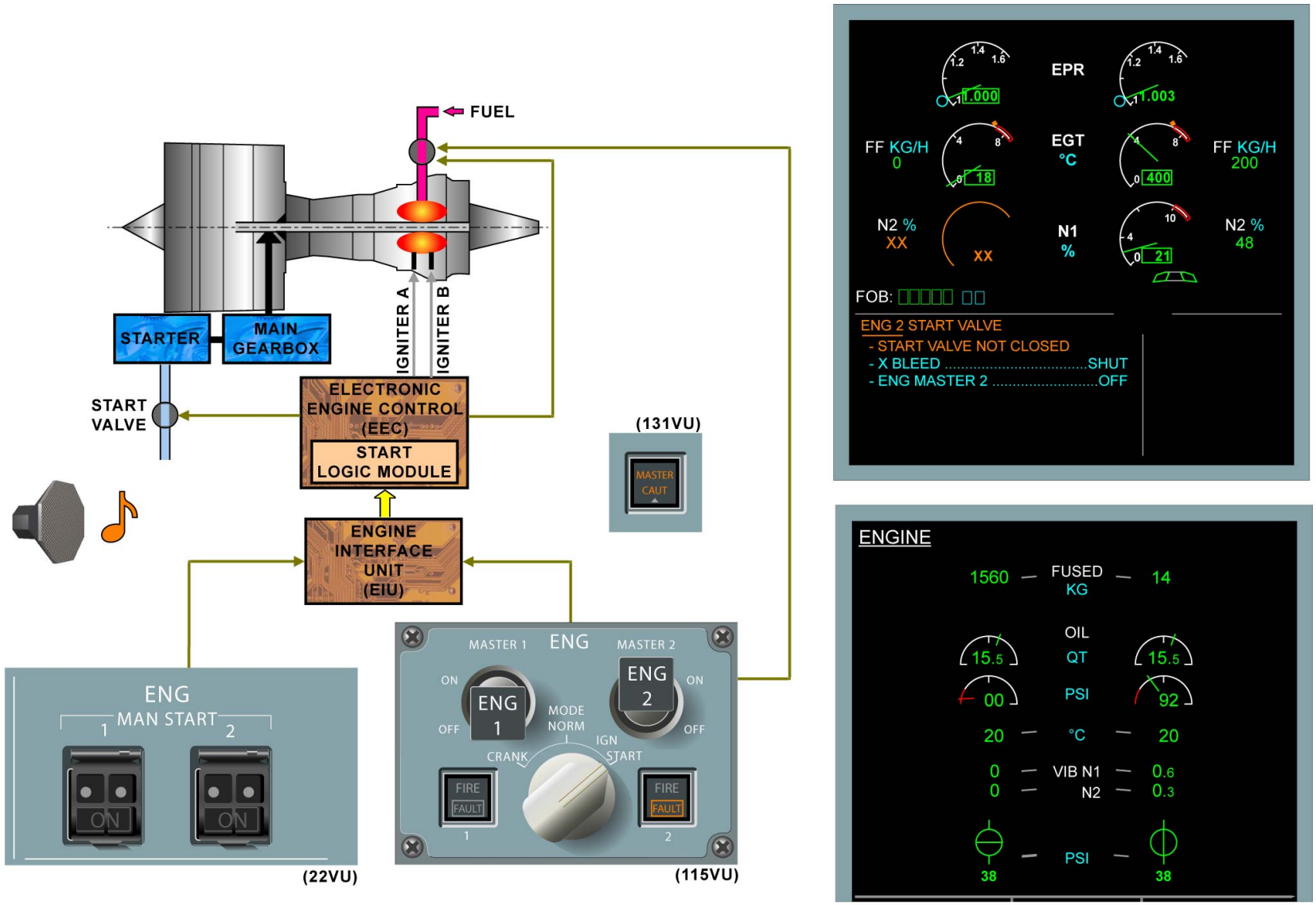
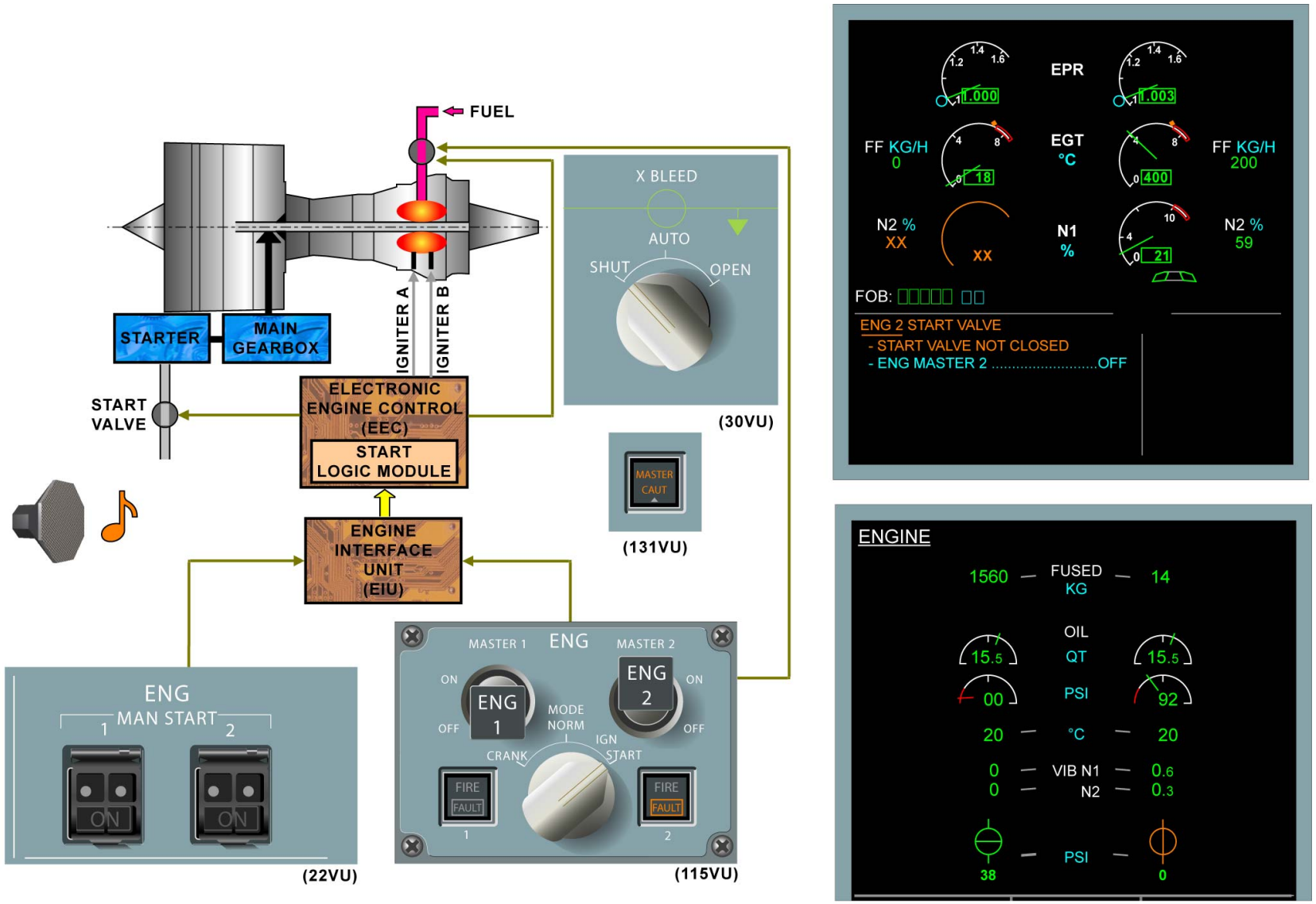
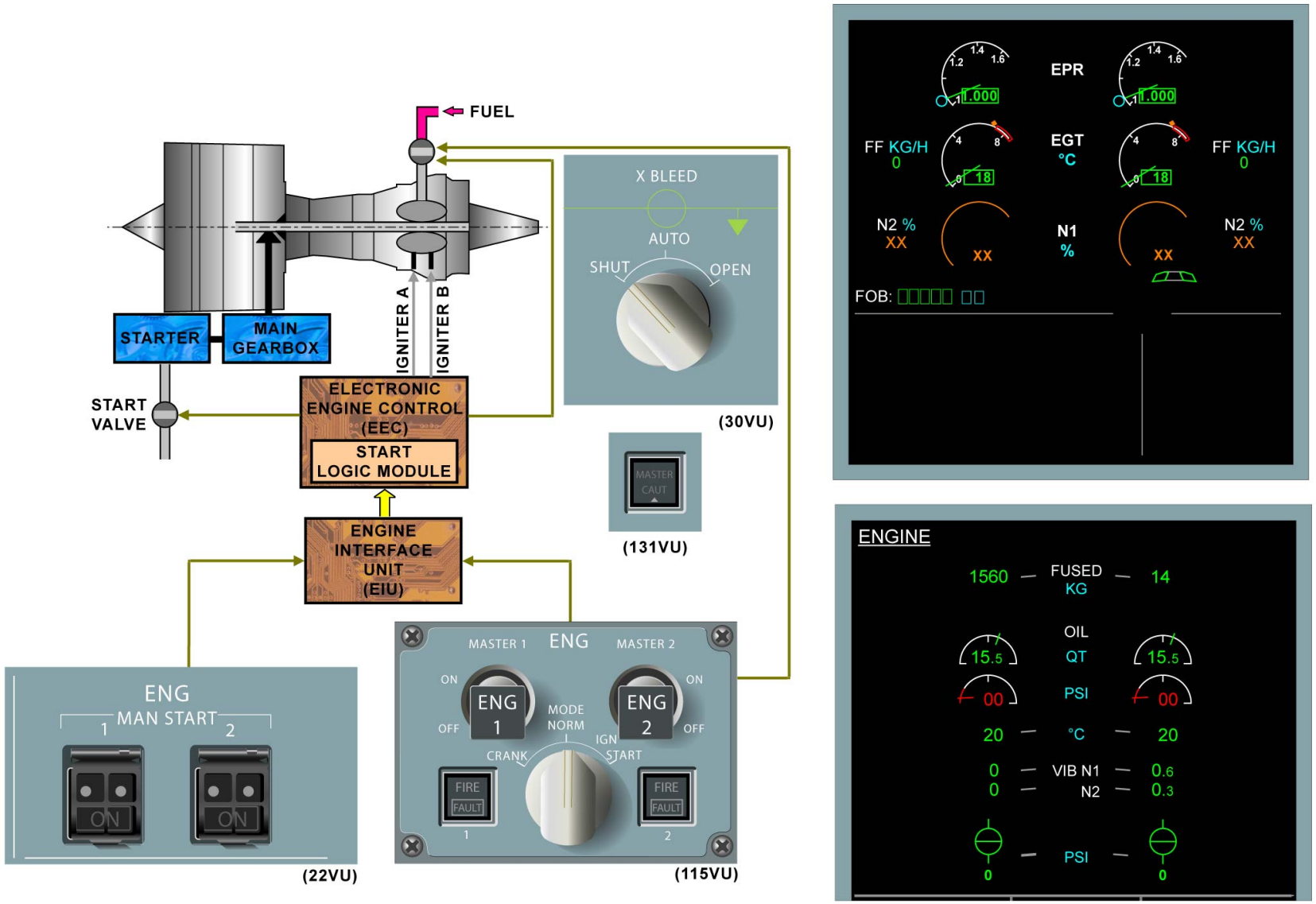


START VALVE (NOT CLOSED)



START VALVE (NOT CLOSED)

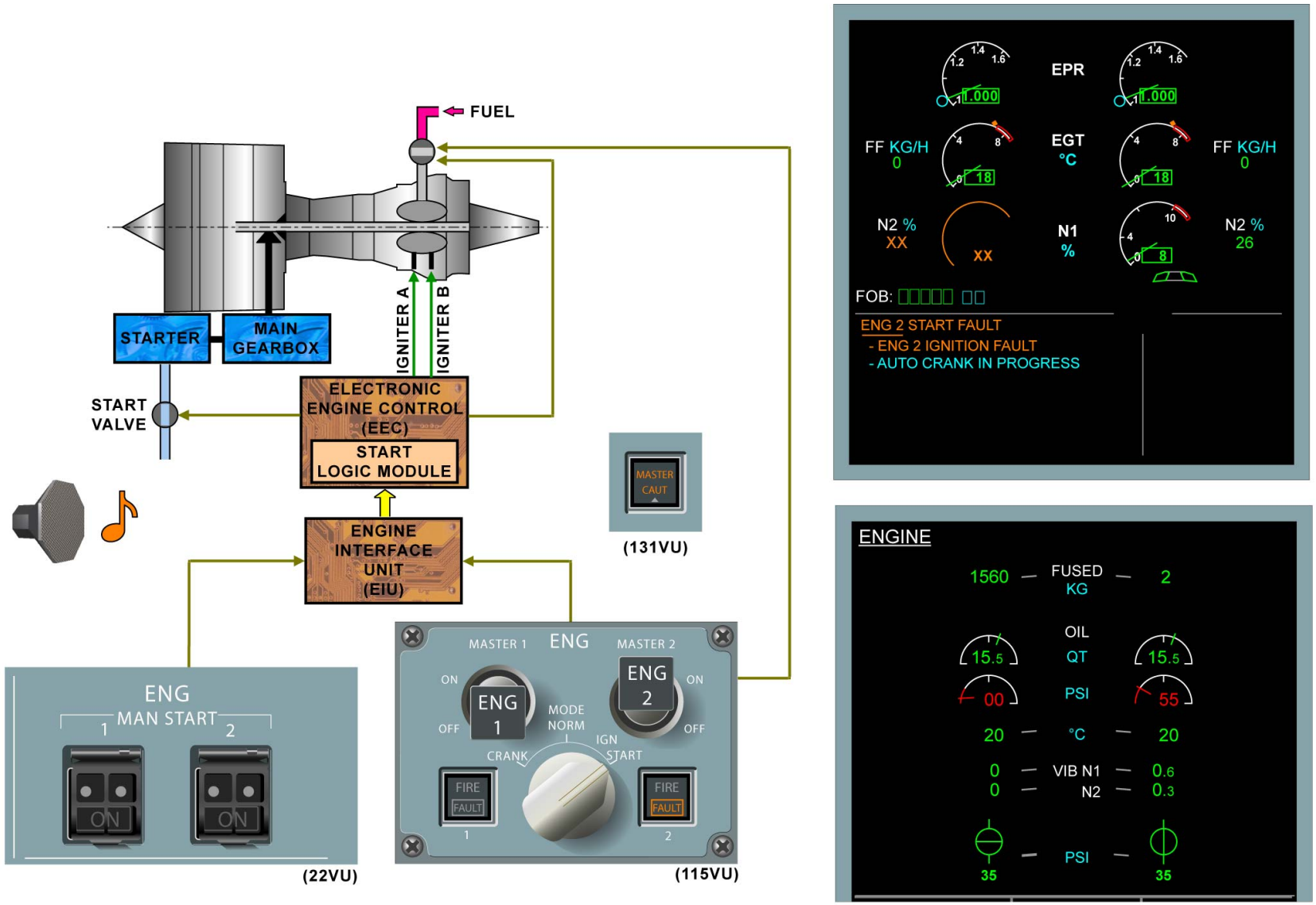


START VALVE (NOT CLOSED)

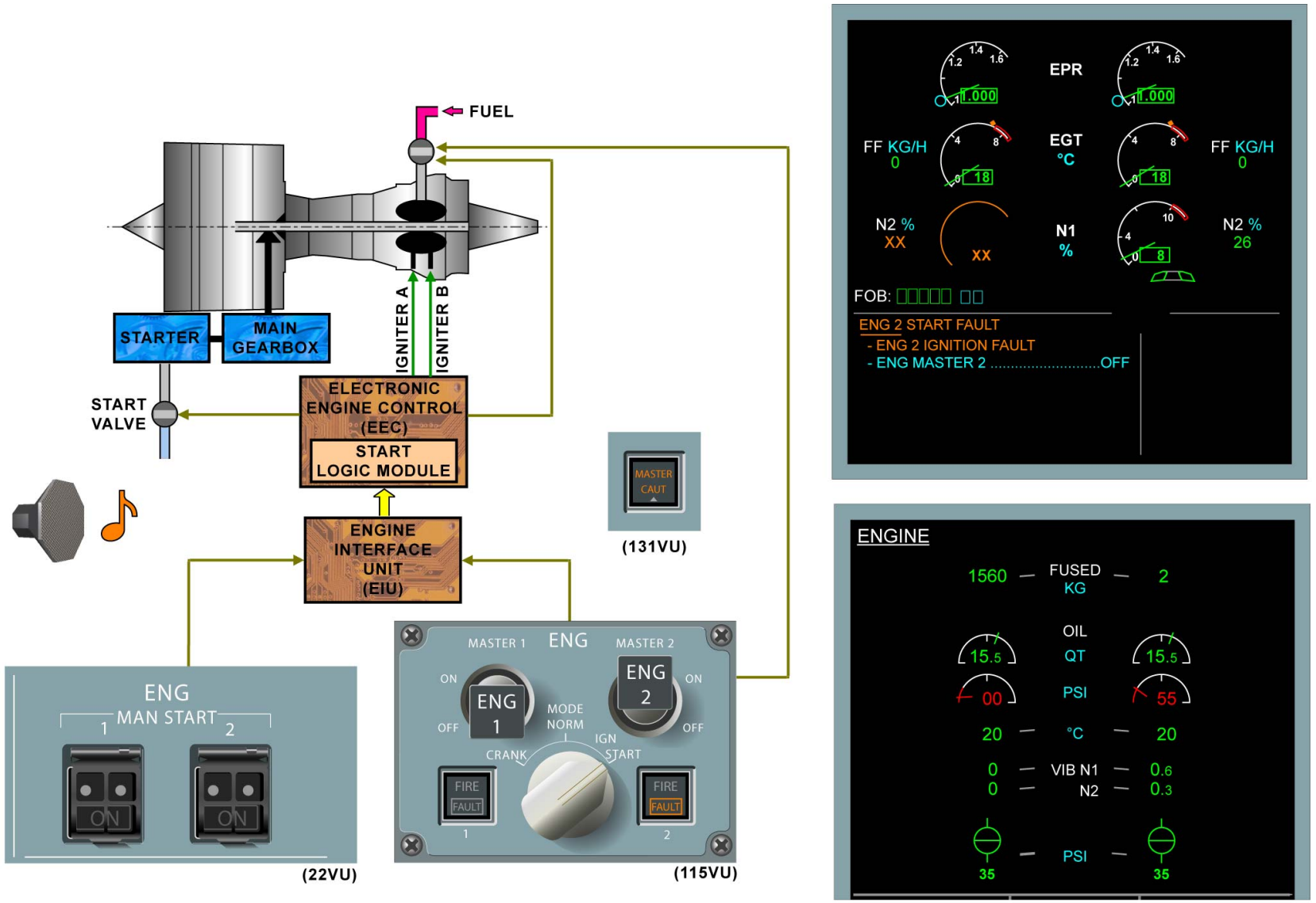
START FAILURES (ME) (3)

START FAULT (IGNITION AUTOMATIC MODE)

If an ignition fault occurs, an aural warning operates. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. The FADEC stops the fuel supply and ignition, and automatically supplies airflow to the engine.
The FADEC then closes the start valve. Then the MASTER lever must be set to OFF.



START FAULT (IGNITION AUTOMATIC MODE)



START FAULT (IGNITION AUTOMATIC MODE)

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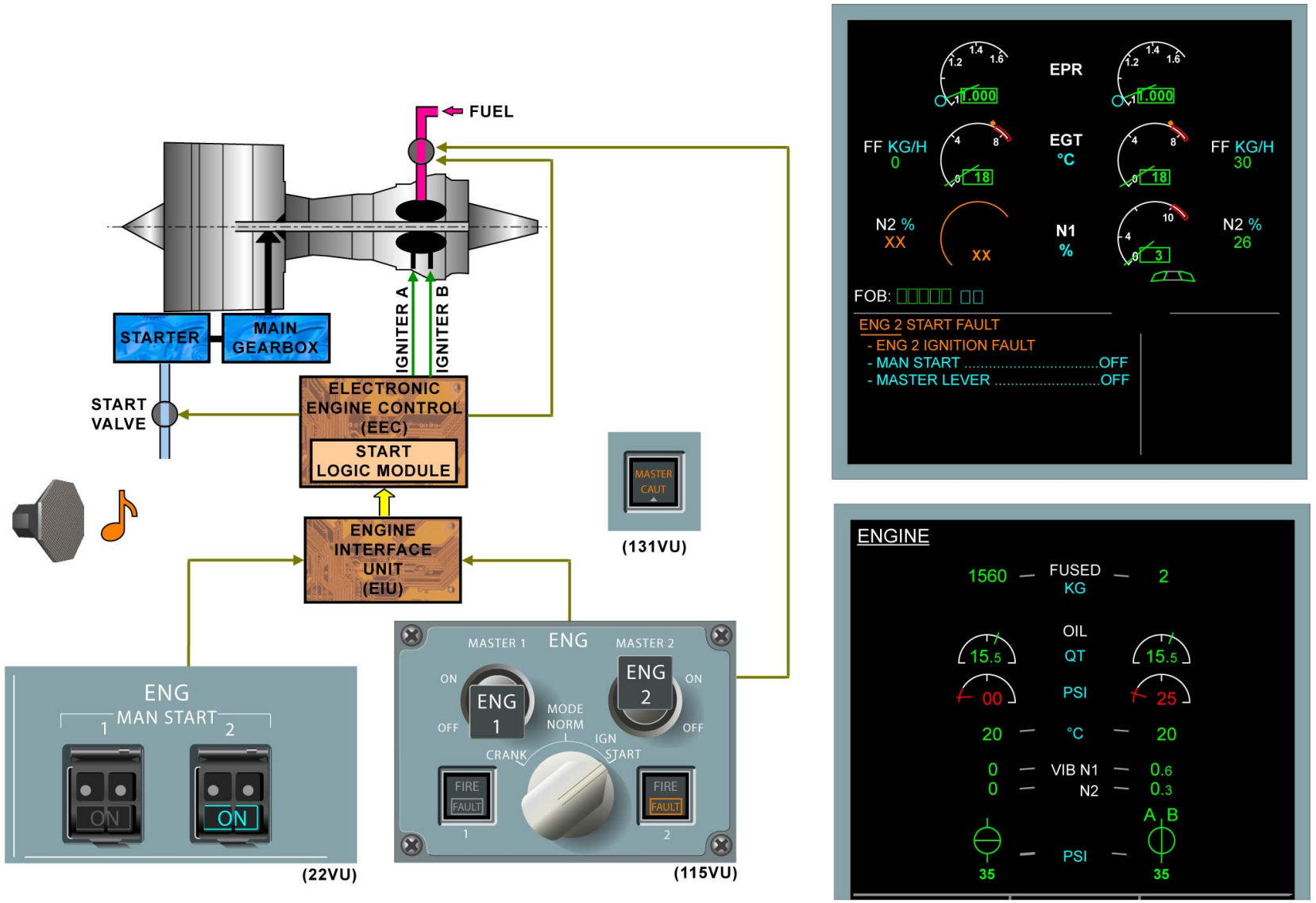
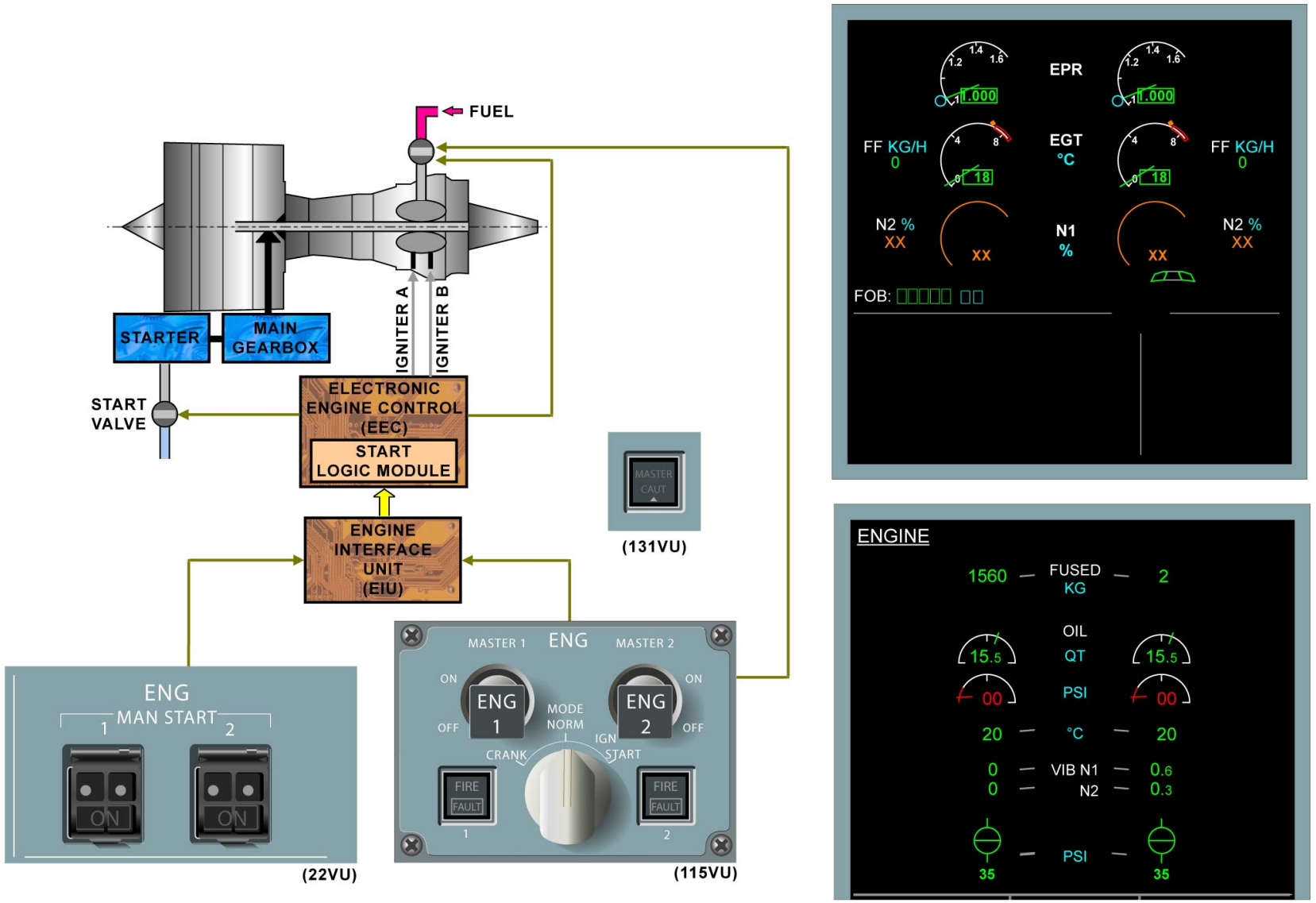
START FAILURES (ME) (3)

START FAULT (IGNITION MANUAL MODE)

If an IGNITION FAULT occurs, an aural warning operates. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. In manual start, the FADEC does not abort the start.
You must do the necessary procedure to stop the engine.



START FAULT (IGNITION MANUAL MODE)



START FAULT (IGNITION MANUAL MODE)

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START FAILURES (ME) (3)

START FAULT (STALL AUTOMATIC MODE)

If there is a sensed stall or Exhaust Gas Temperature (EGT) overlimit, the FADEC auto-start control or the flight crew operations are identical.
When a stall or an EGT overlimit is sensed, an aural warning operates, the MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. The FADEC stops the fuel and the ignition, then a dry crank phase is automatically done.
After the auto-cranking, the FADEC aborts the start sequence. Then the MASTER lever must be set to OFF.

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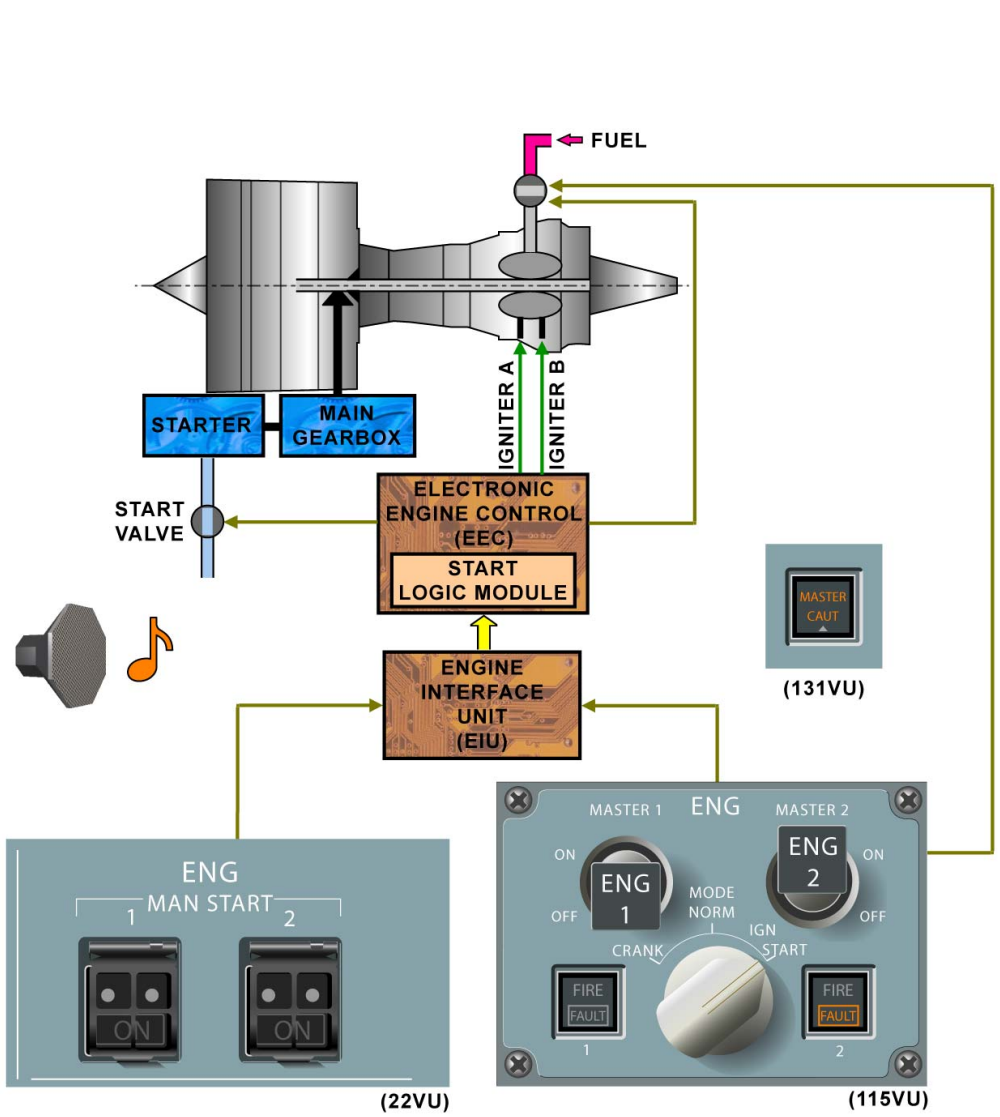
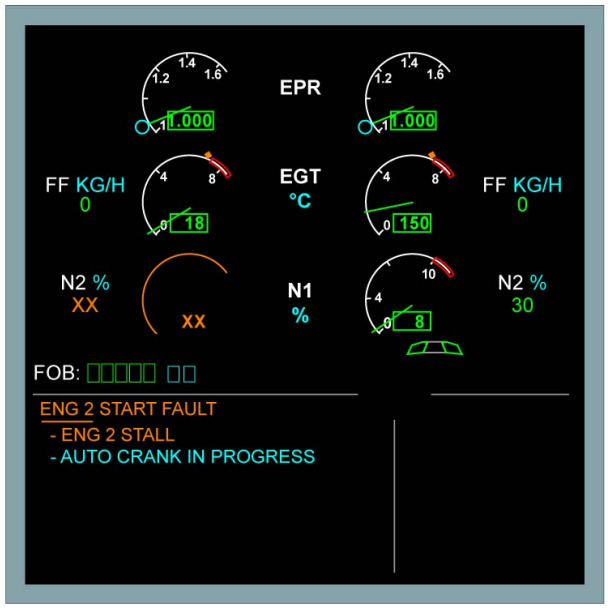
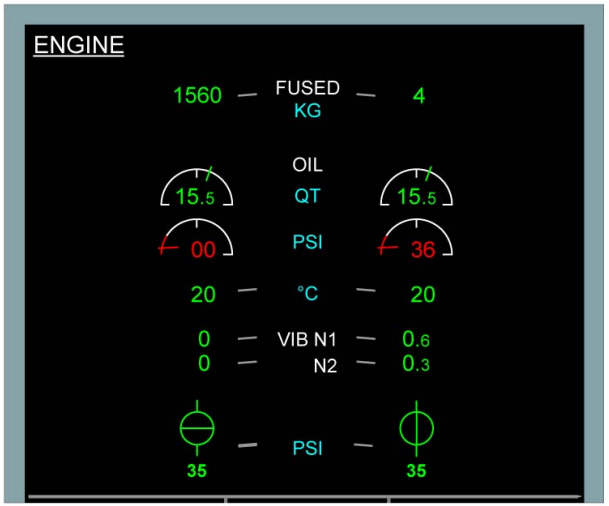
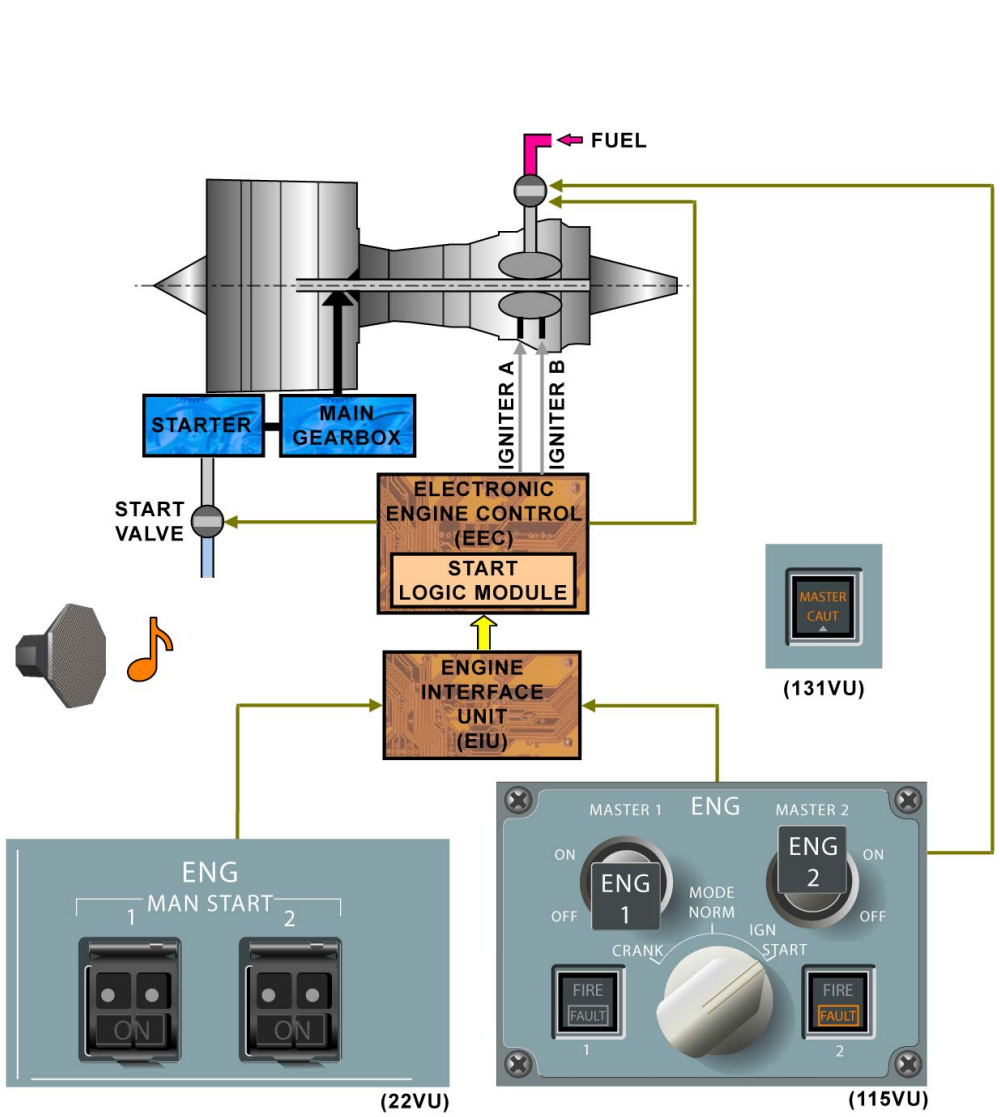
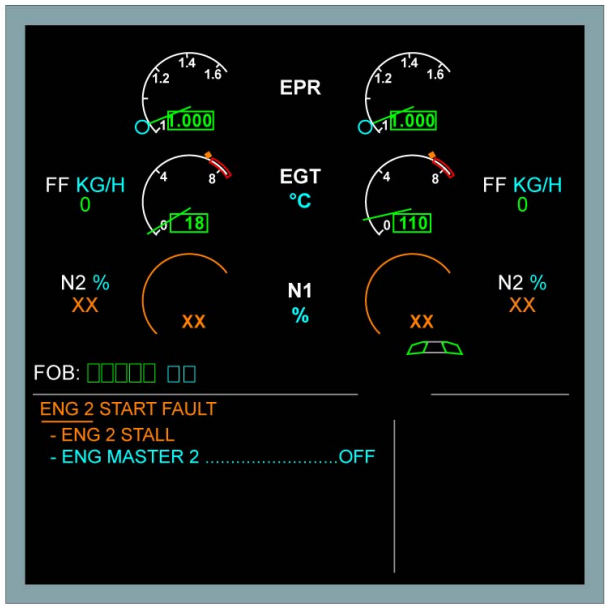


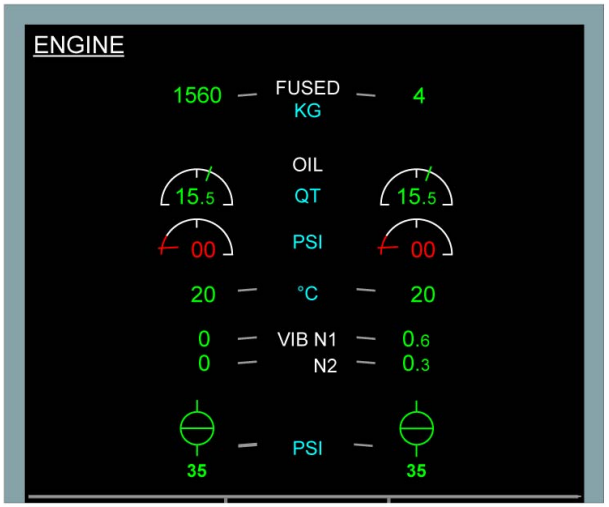




START FAULT (STALL AUTOMATIC MODE)







START FAULT (STALL AUTOMATIC MODE)

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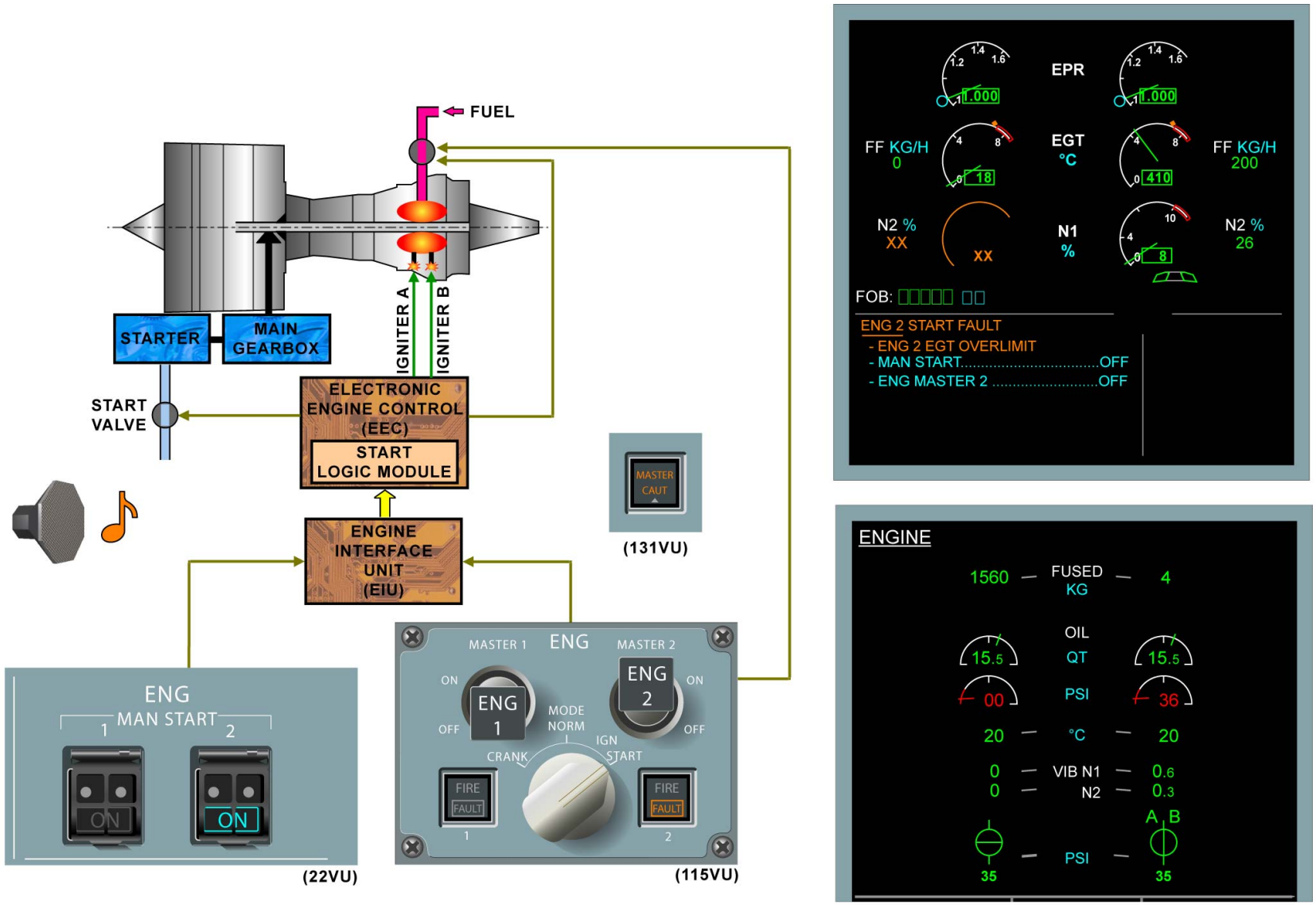
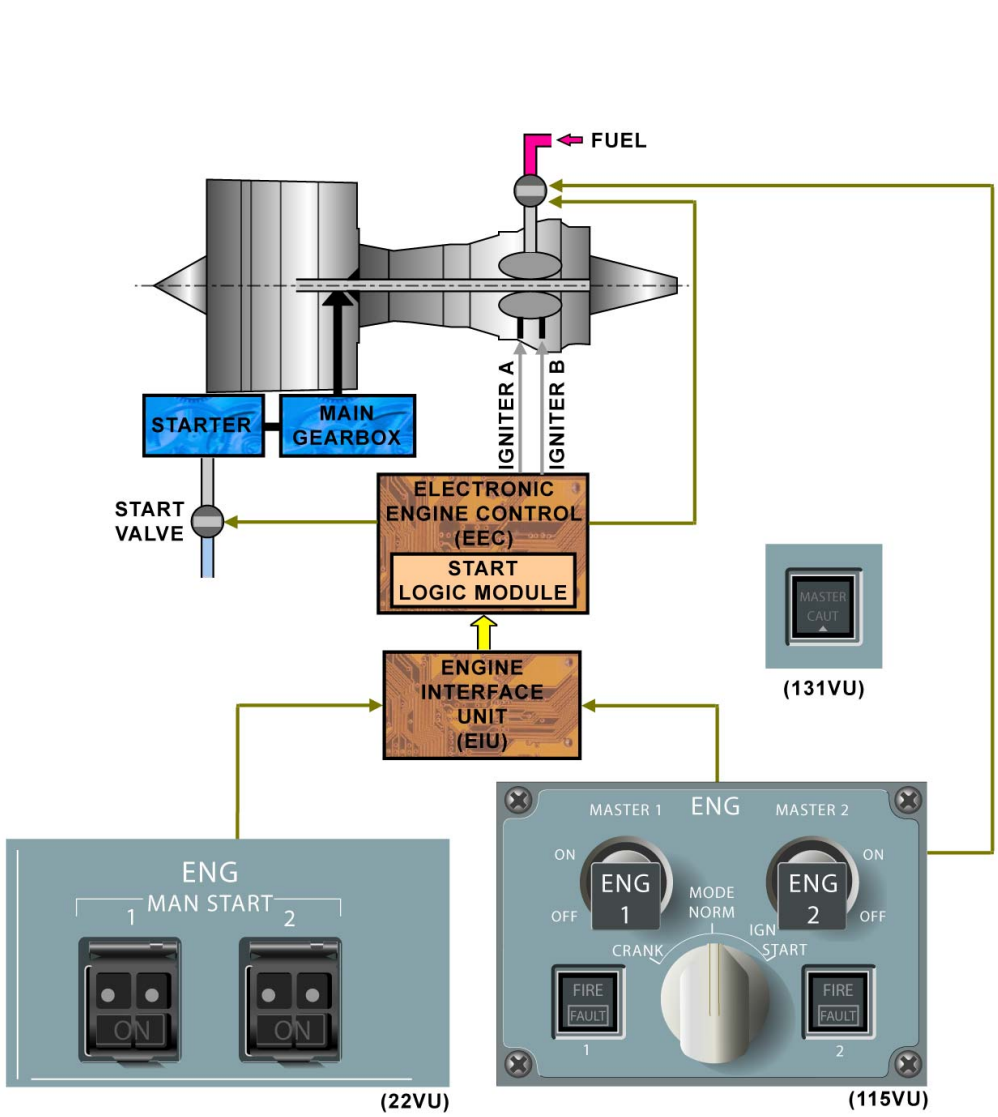
START FAILURES (ME) (3)

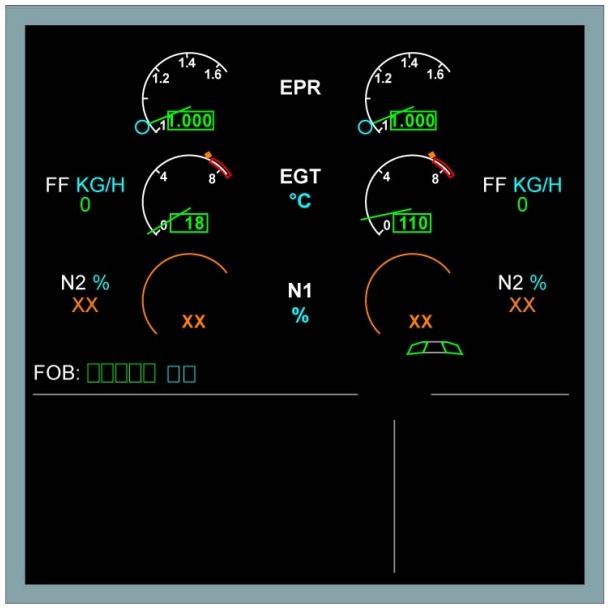
START FAULT (FAILURE DURING ENG MANUAL START MODE)

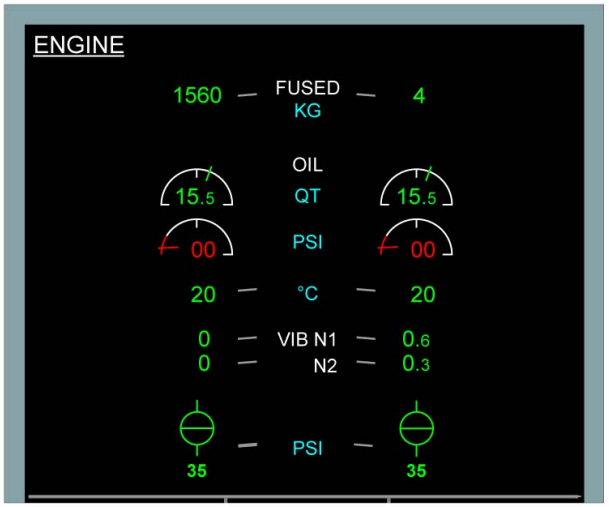
During the start, in case of EGT exceedance, an aural warning is triggered. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. In manual start, the FADEC does not abort the start.
The Crew operates the MASTER LEVER switch to OFF to stop the engine, as per ECAM procedure.



START FAULT (FAILURE DURING ENG MANUAL START MODE)







START FAULT (FAILURE DURING ENG MANUAL START MODE)

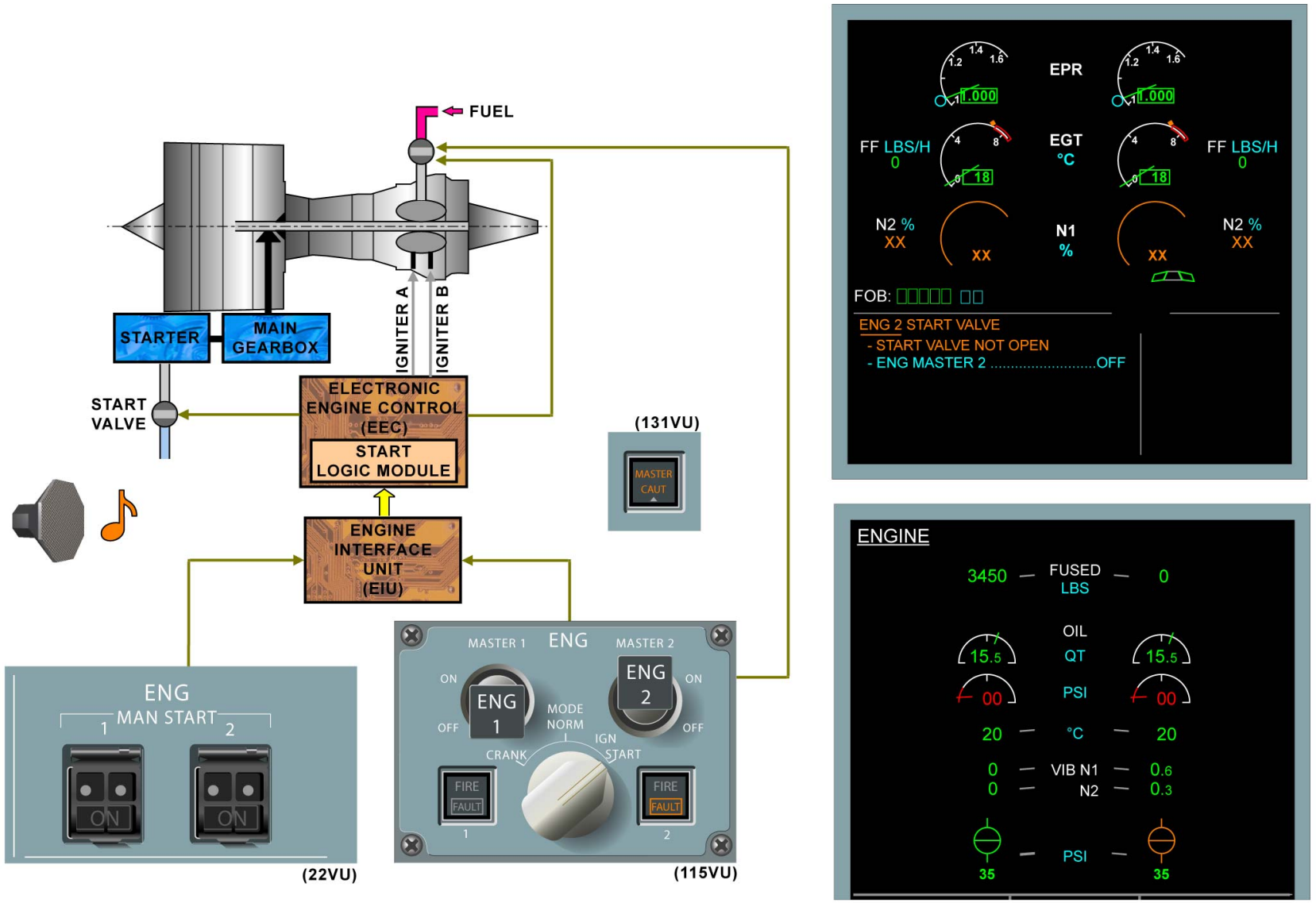
EWD: FAILURE TITLE CONDITIONS	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNINGS
START VALVE (NOT OPEN)	SINGLE CHIME	MASTER CAUT	ENG	ENG FAULT LT
START VALVE (NOT CLOSED)				
START FAULT (IGNITION AUTOMATIC MODE)				
START FAULT (IGNITION MANUAL MODE)				
START FAULT (STALL AUTOMATIC MODE)				
START FAULT (EGT OVERLIMIT MANUAL MODE)				

START FAULT (FAILURE DURING ENG MANUAL START MODE)

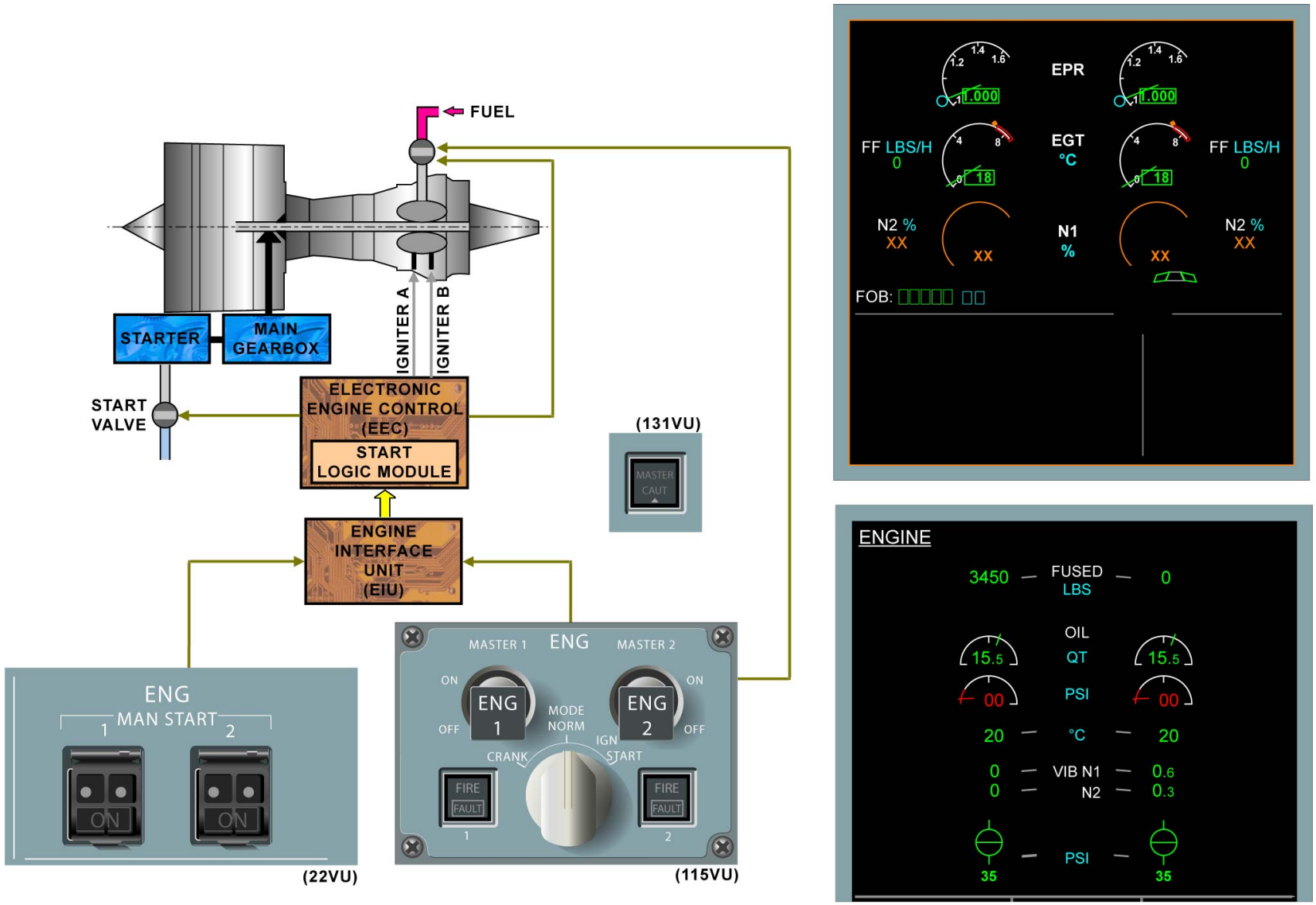
START FAILURES (US) (3)

START VALVE (NOT OPEN)

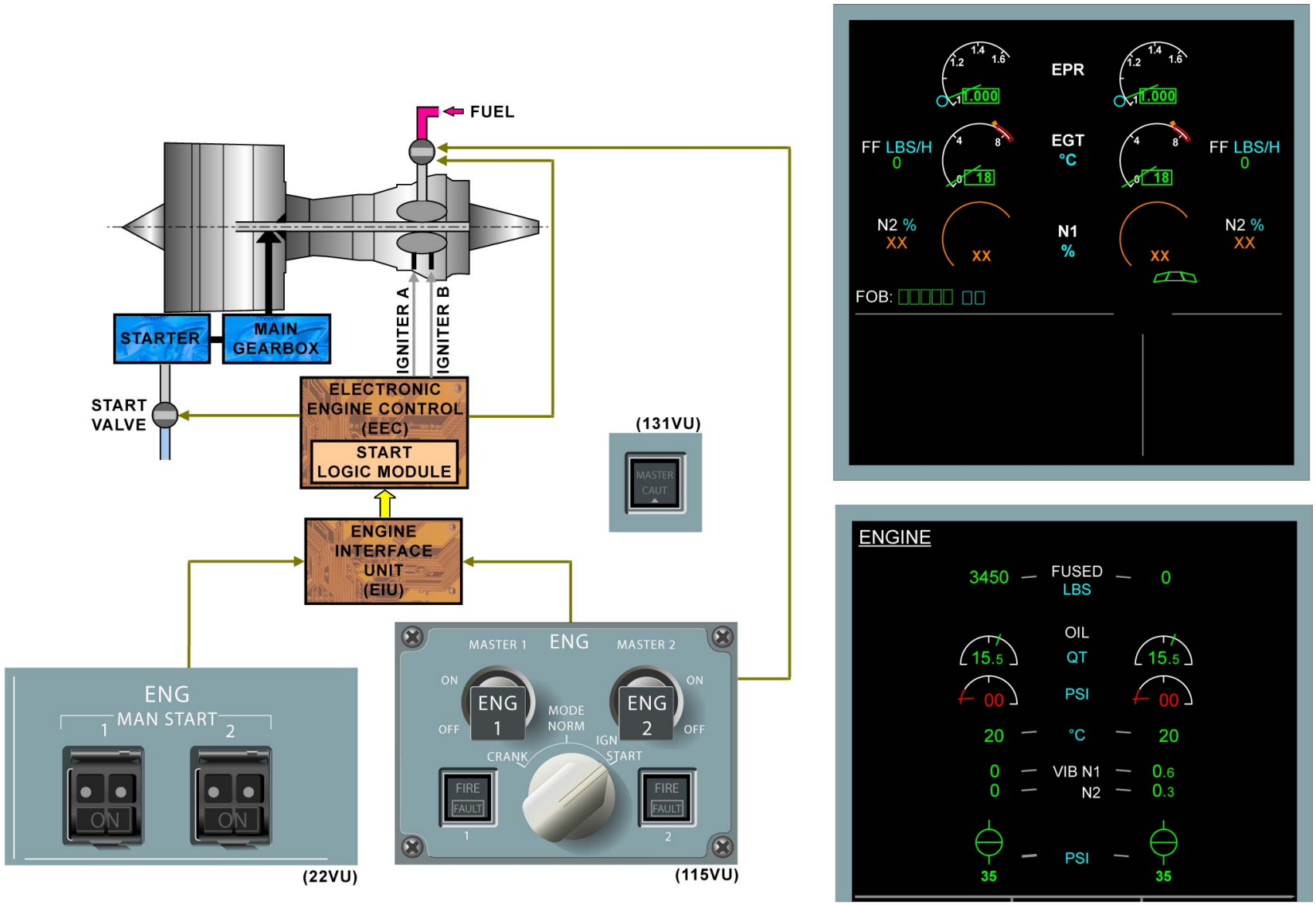
If the start valve does not open, an aural warning sounds. The MASTER CAUTion and the ENGine FAULT light come on. An ECAM message appears. The Full Authority Digital Engine Control (FADEC) aborts the start sequence.
Another start with a manual operation of the start valve will be performed.
For this advise the ground crew to prepare for a start valve manual operation. Check that if the opposite engine is running, the X BLEED P/B is ON, or if APU is available, the APU BLEED P/B is ON.
Perform an automatic start, set the MODE selector to IGNition.
When the MASTER lever is set to ON, order the ground crew to open the start valve.
The start valve is opened.
When N2 reaches 43%, order the ground crew to close the start valve.
The start valve is closed, the engine is running now, continue with the normal procedure.



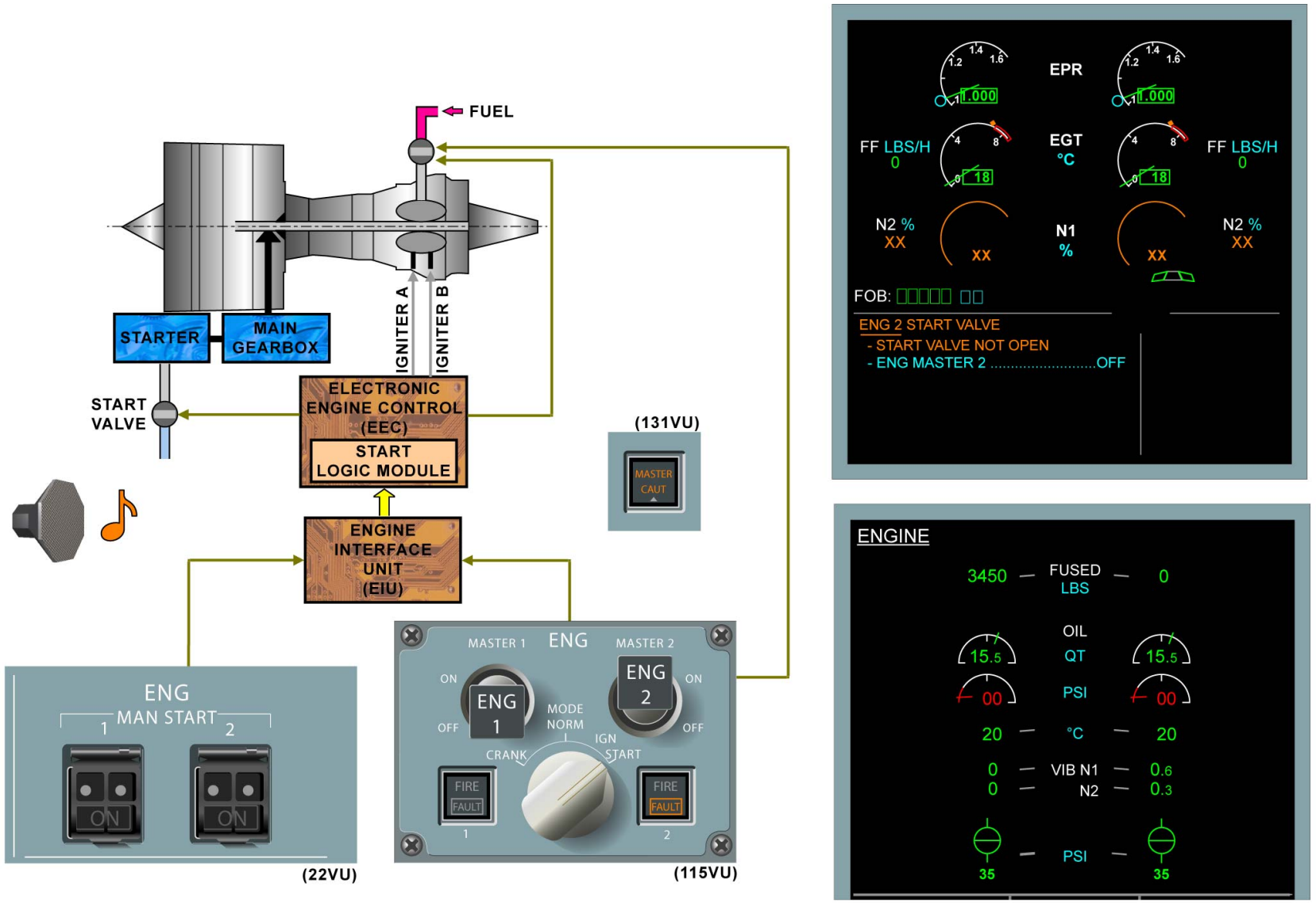
START VALVE (NOT OPEN)



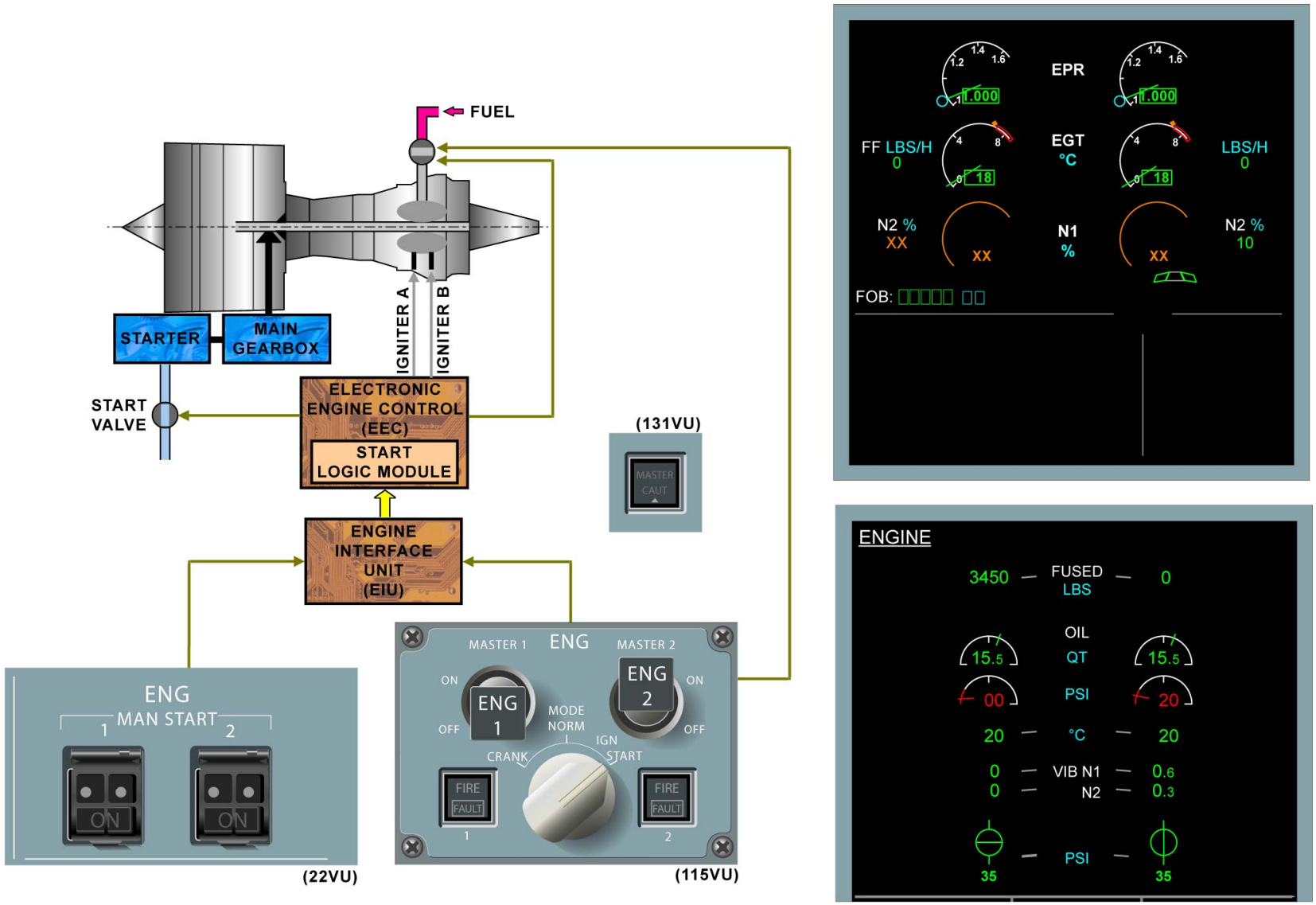
START VALVE (NOT OPEN)



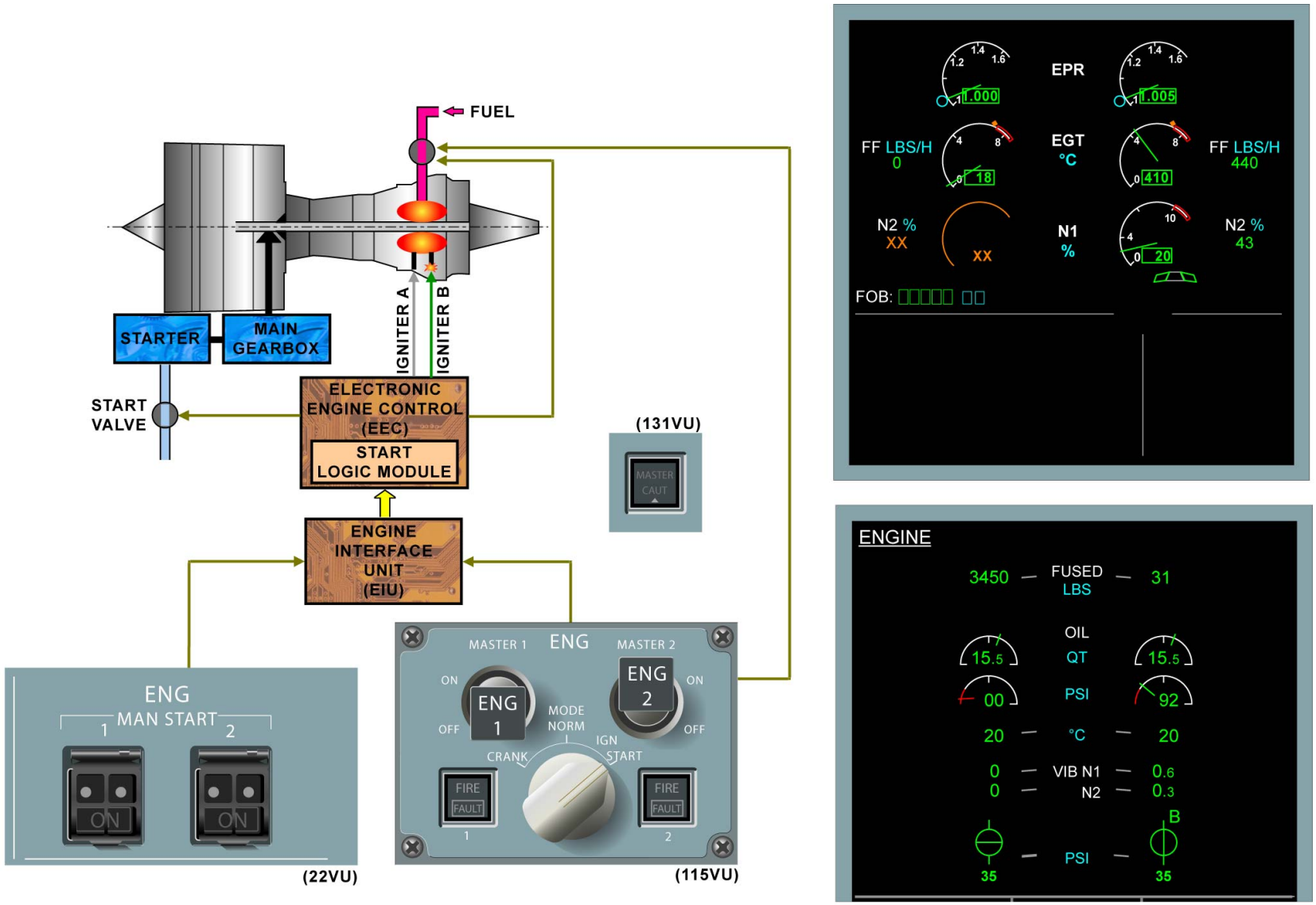
START VALVE (NOT OPEN)



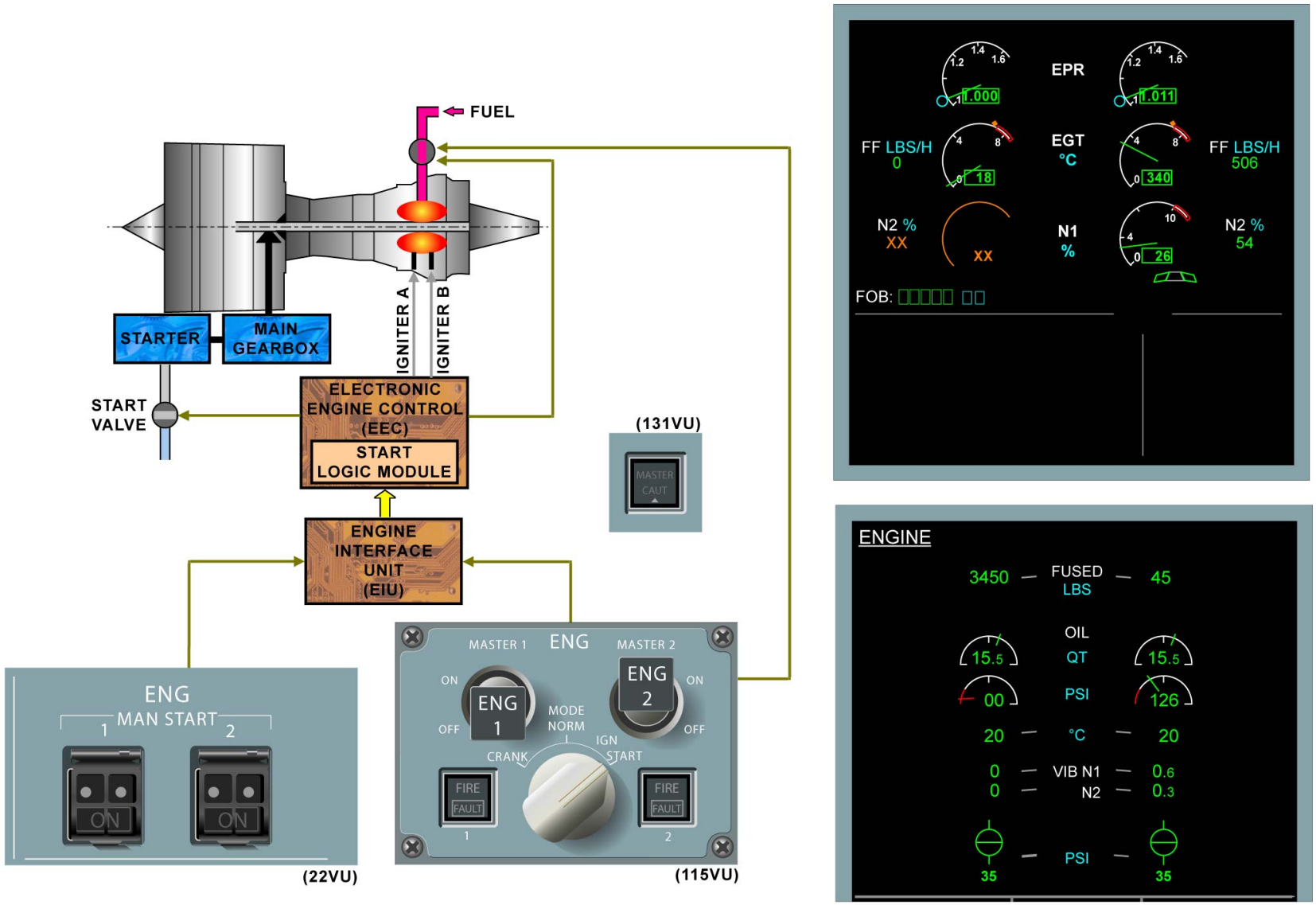
START VALVE (NOT OPEN)



START VALVE (NOT OPEN)



START VALVE (NOT OPEN)



START VALVE (NOT OPEN)

START FAILURES (US) (3)

START VALVE (NOT CLOSED)

At 43% of N2, the FADEC sends a signal to close the start valve. If the start valve does not close, an aural warning sounds. The MASTER CAUT and the ENG FAULT light come on. An ECAM message appears. You must perform the START VALVE NOT CLOSED procedure.
For this, you must remove all bleed sources supplying the faulty start valve.
Set the APU BLEED P/B (if engine 1 is affected) to OFF.
Set the X BLEED selector to SHUT.
Set the MASTER lever to OFF, then set the MODE selector to NORM.
Restart is not allowed, and a maintenance action is required.

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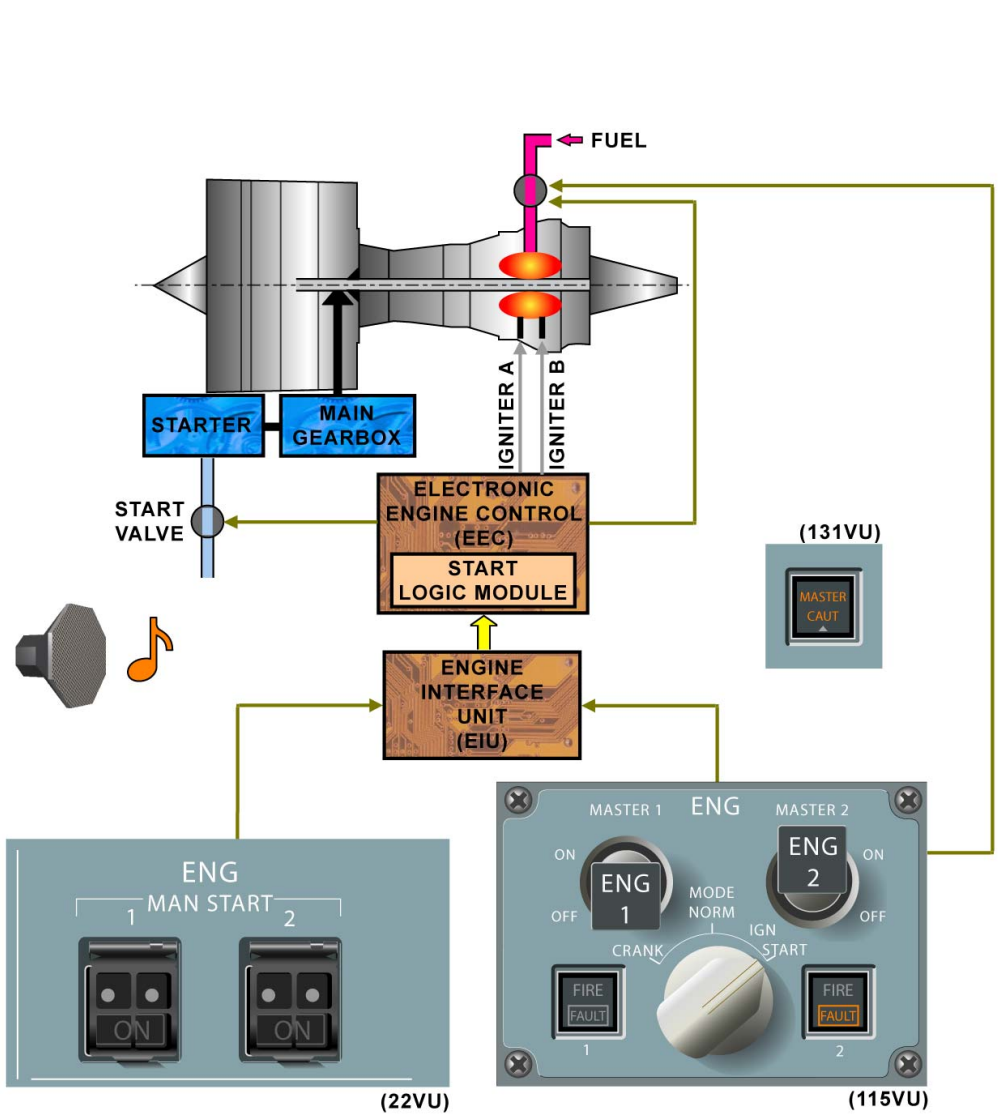
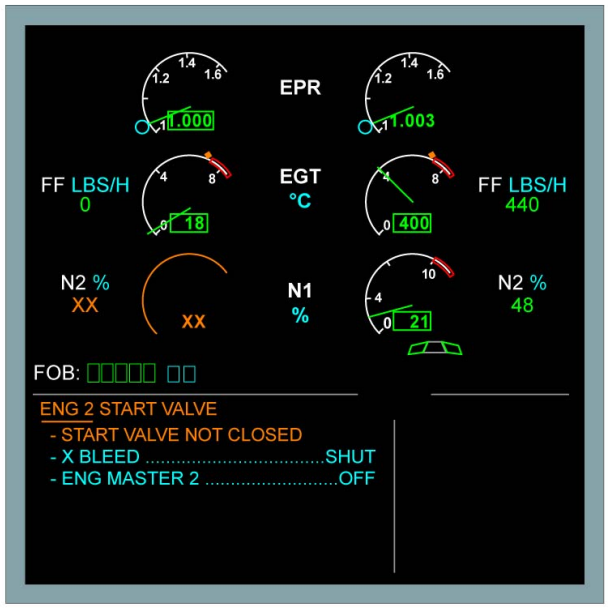
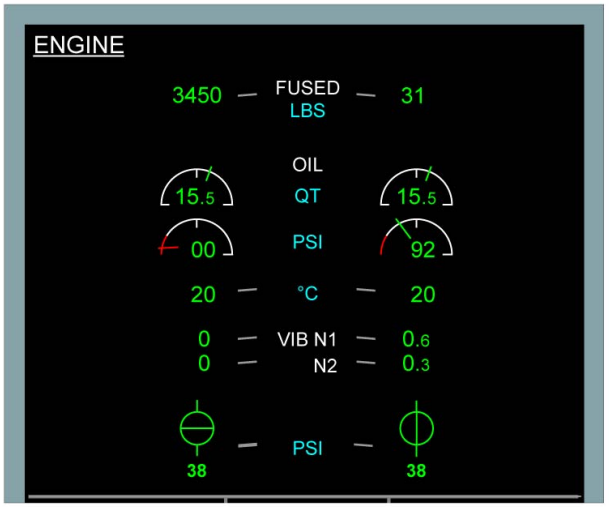
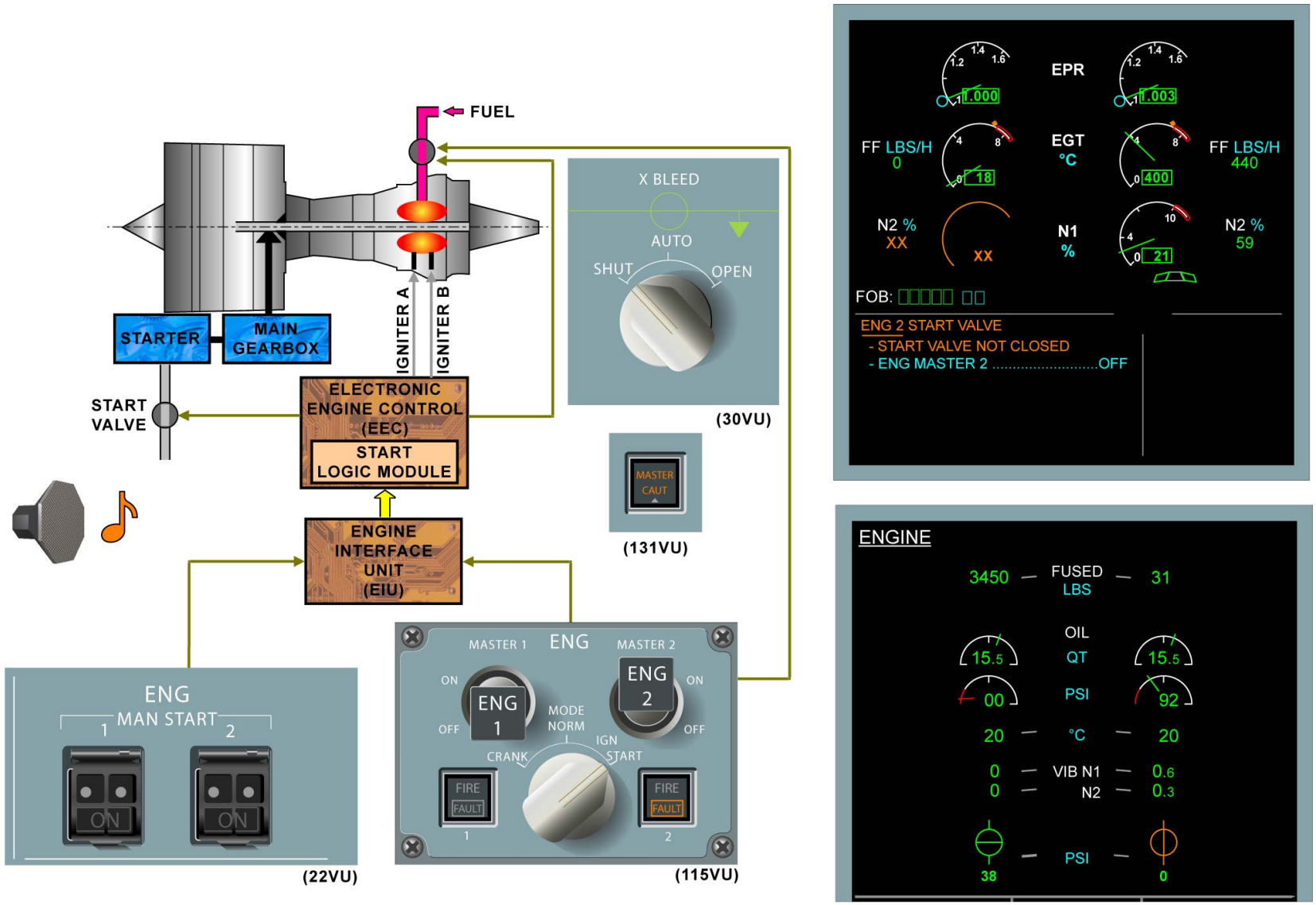


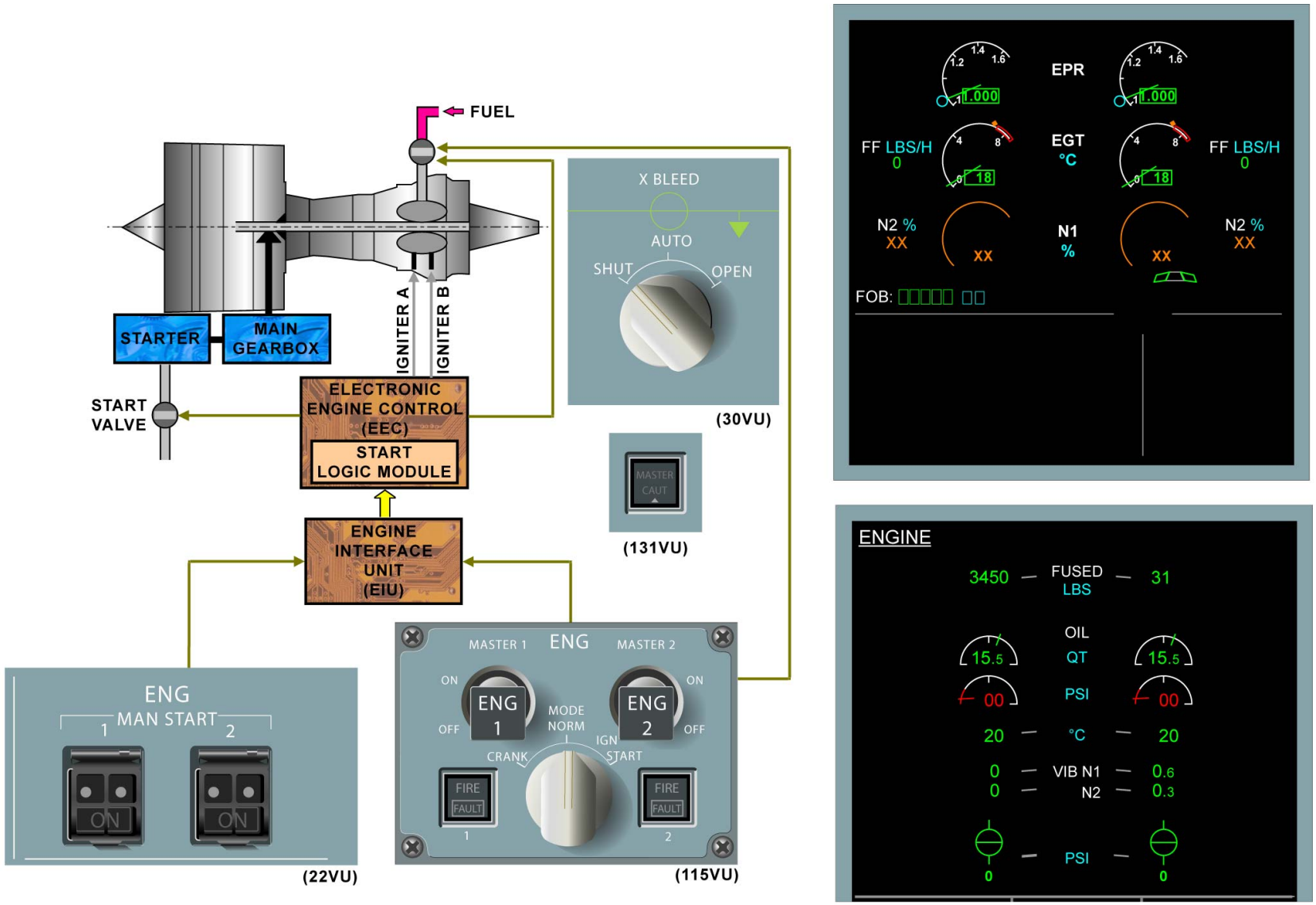




START VALVE (NOT CLOSED)



START VALVE (NOT CLOSED)



START VALVE (NOT CLOSED)

START FAILURES (US) (3)

START FAULT (IGNITION AUTOMATIC MODE)

If an ignition fault occurs, an aural warning sounds. The MASTER CAUT and the ENG FAULT light come on. An ECAM message appears. The FADEC cuts the fuel supply and ignition, automatically ventilates the engine.
The FADEC then closes the start valve. Then the MASTER lever must be set to OFF.

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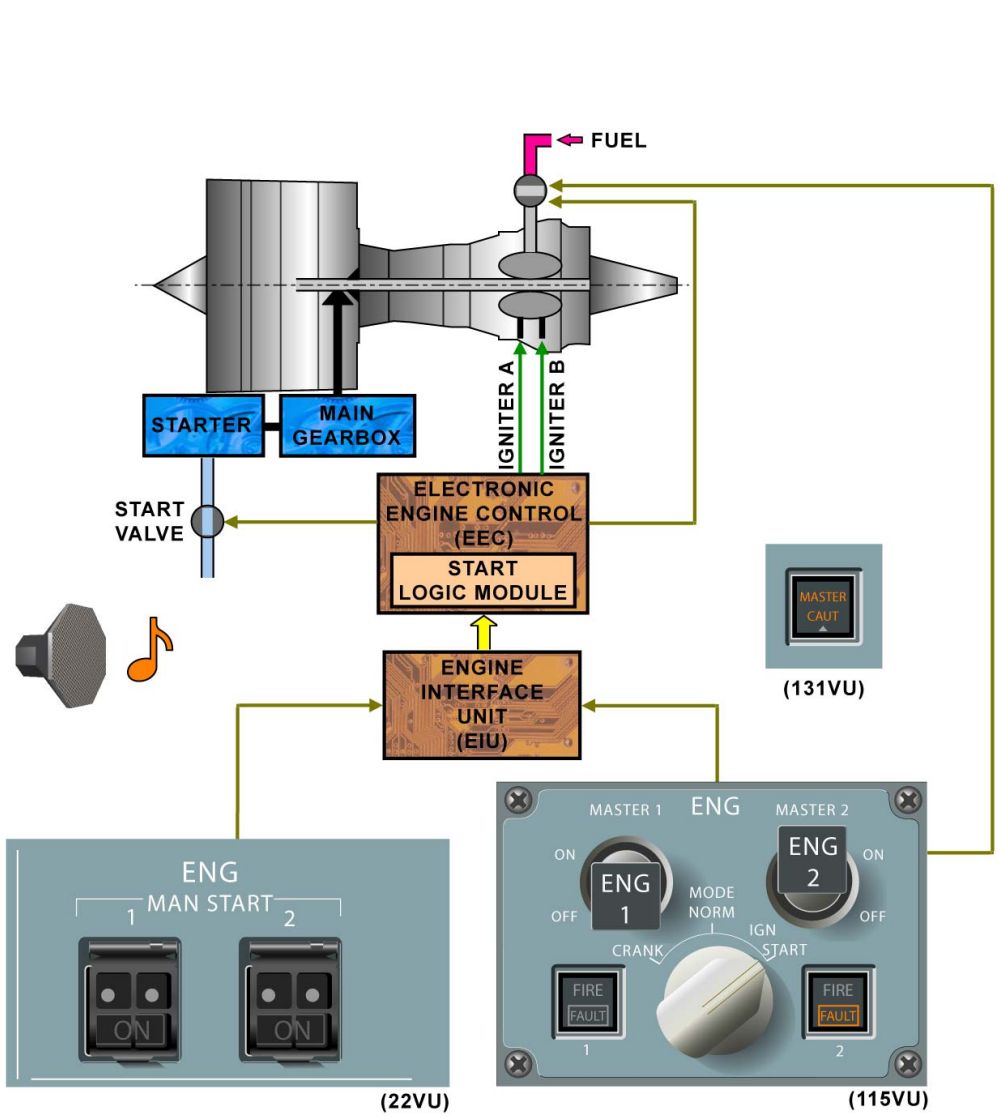
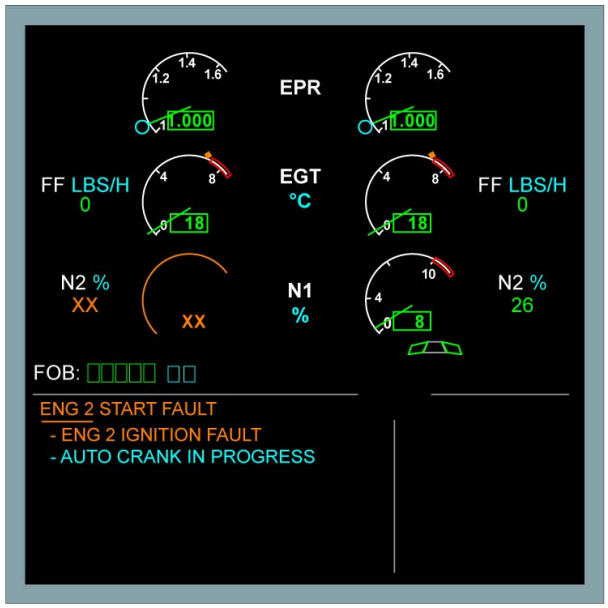
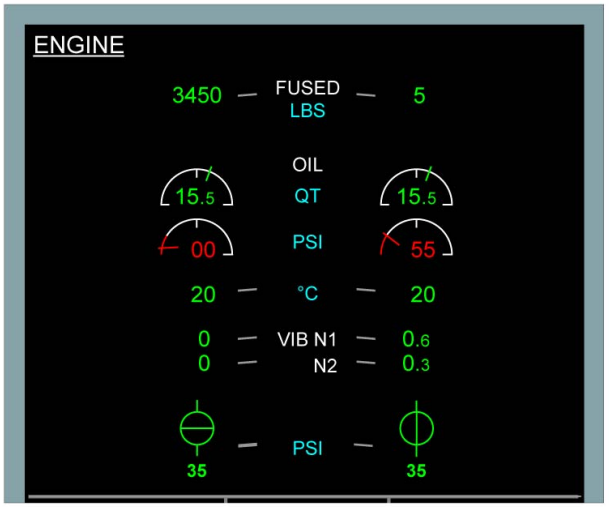
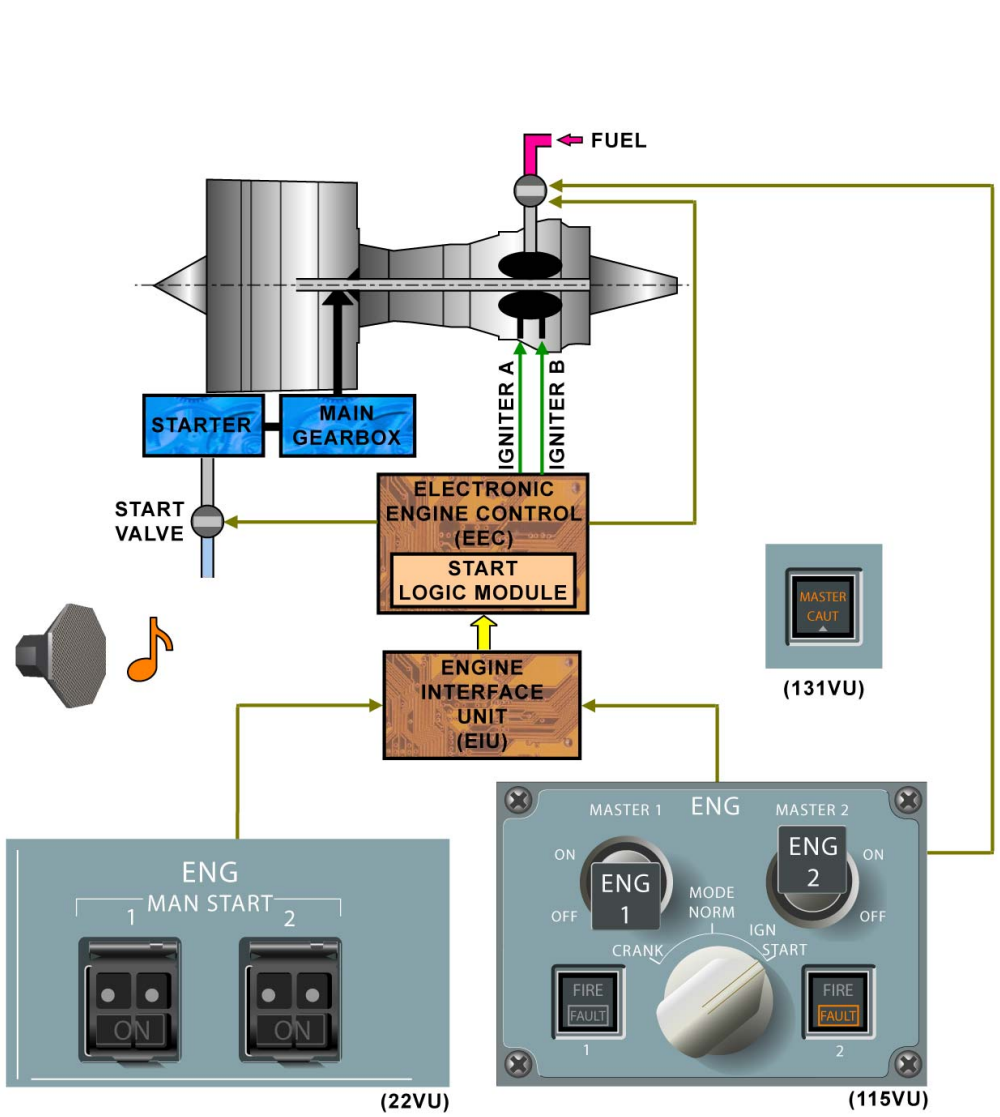
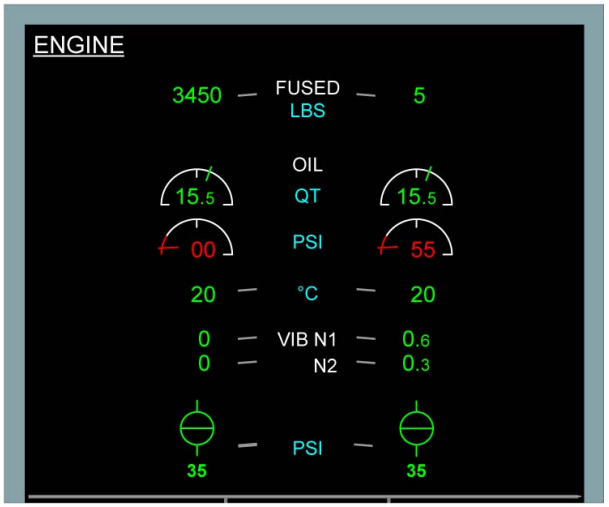






START FAULT (IGNITION AUTOMATIC MODE)





START FAULT (IGNITION AUTOMATIC MODE)

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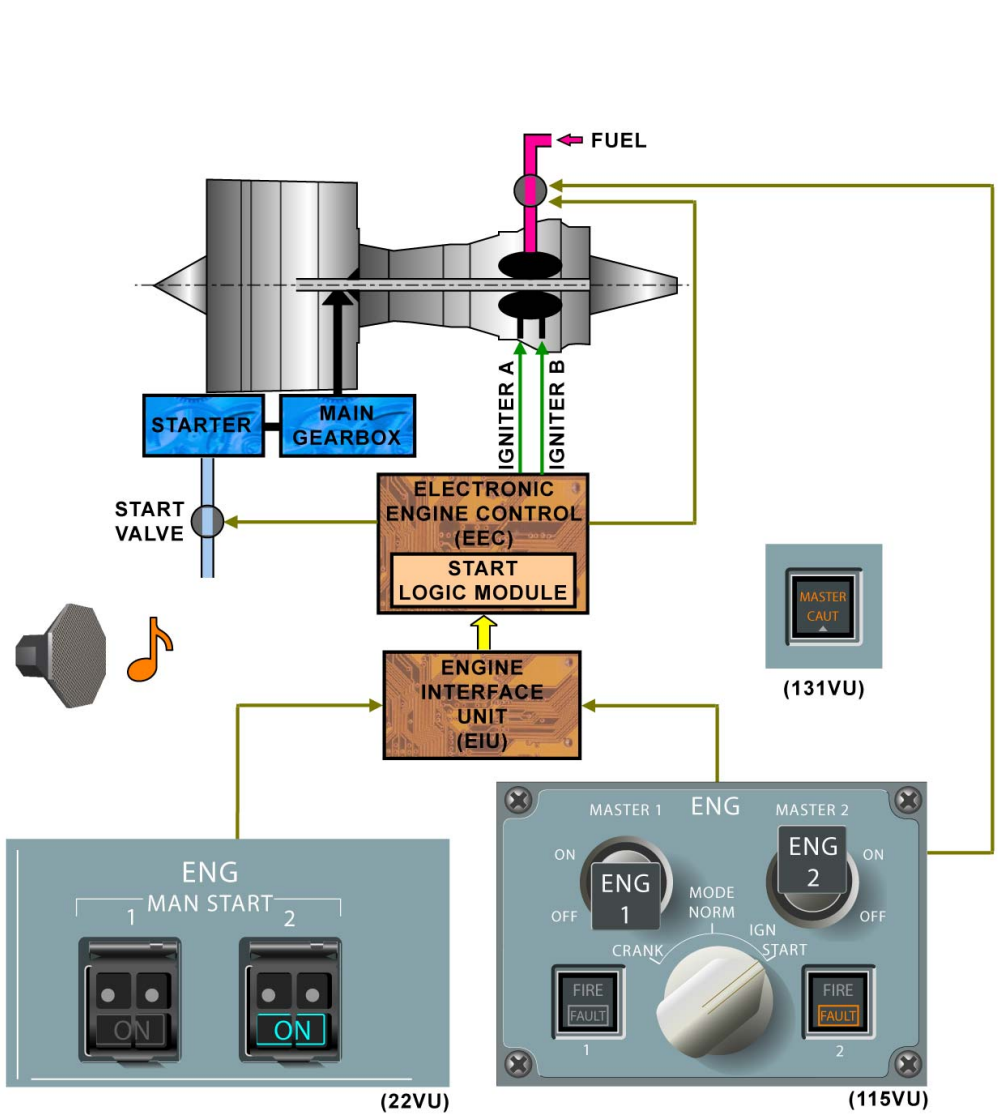
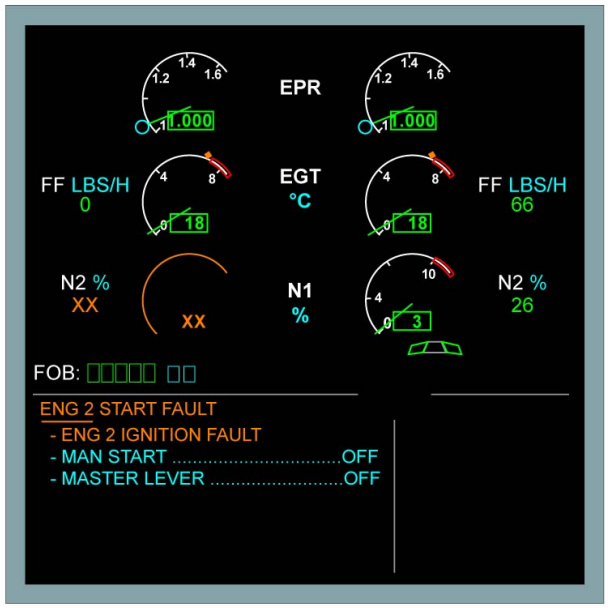
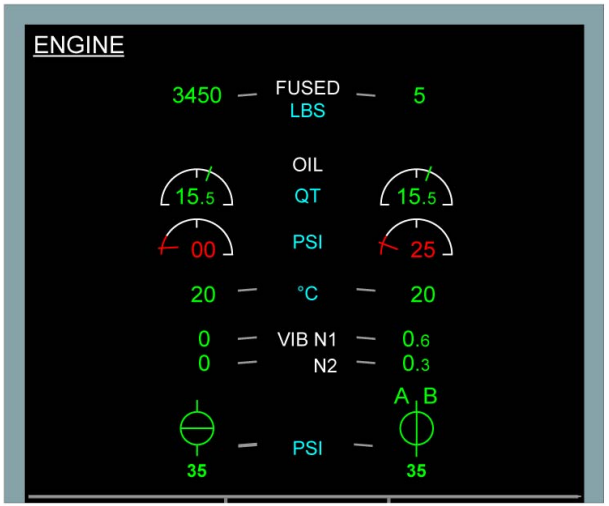
START FAILURES (US) (3)

START FAULT (IGNITION MANUAL MODE)

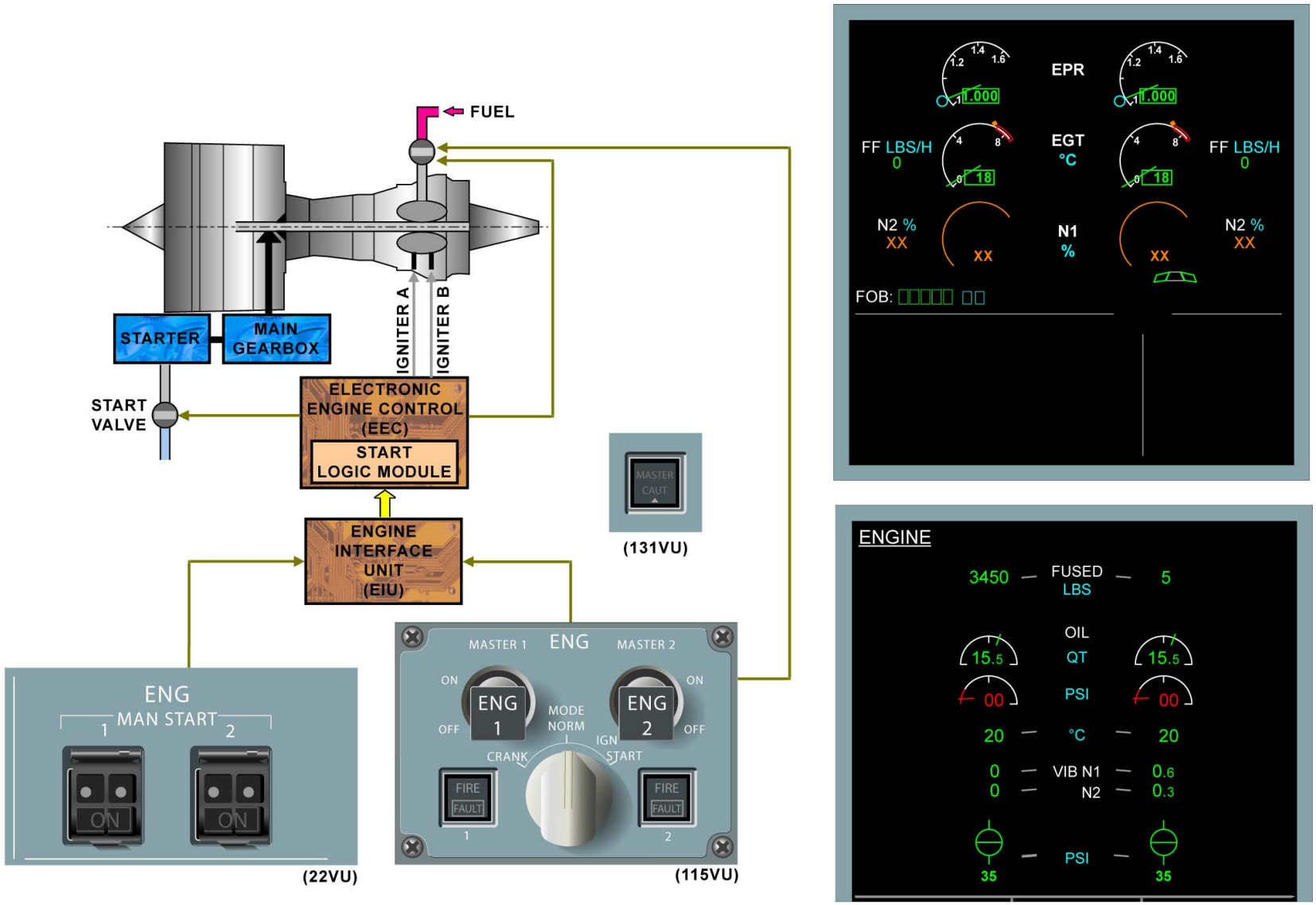
If an ignition fault occurs, an aural warning sounds. The MASTER CAUT and the ENG FAULT light come on. An ECAM message appears. In manual start, the FADEC does not abort the start.
You must perform the action necessary to shut down the engine.







START FAULT (IGNITION MANUAL MODE)



START FAULT (IGNITION MANUAL MODE)

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START FAILURES (US) (3)

START FAULT (STALL AUTOMATIC MODE)

In case of detected stall or Exhaust Gas Temperature (EGT) overlimit, the FADEC auto start control or the flight crew actions are identical.
When a stall or an EGT overlimit is detected, an aural warning sounds, the MASTER CAUT and the ENG FAULT light come on. An ECAM message appears. The FADEC shuts off the fuel and turn off ignition, then a dry crank phase is automatically performed.
After the auto cranking, the FADEC aborts the start sequence. Then the MASTER lever must be set to OFF.

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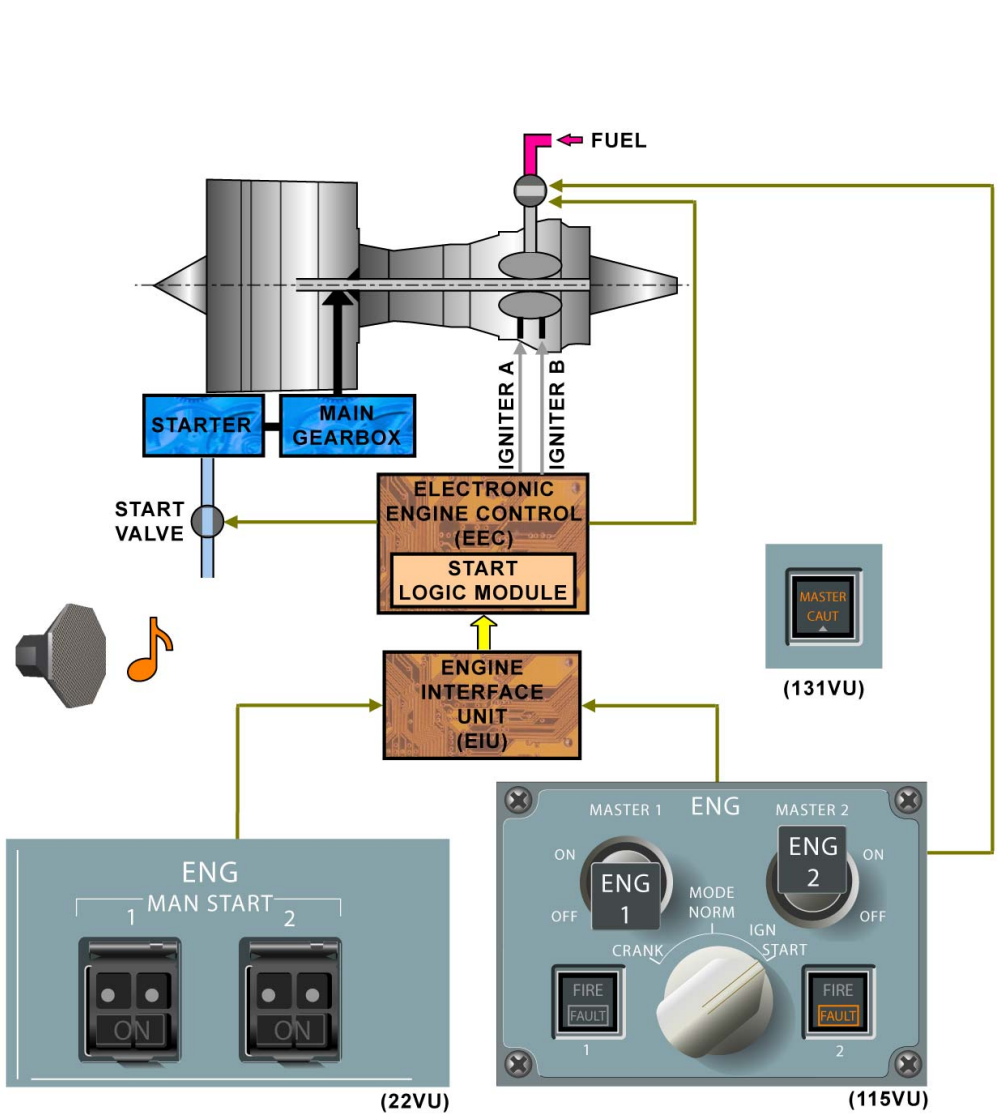
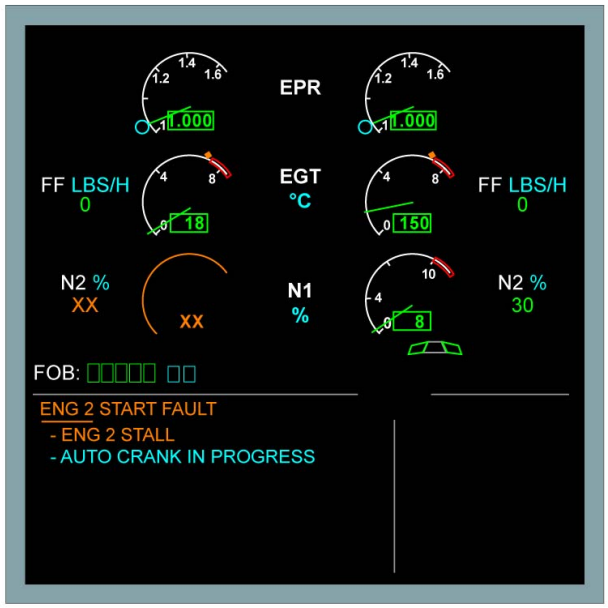
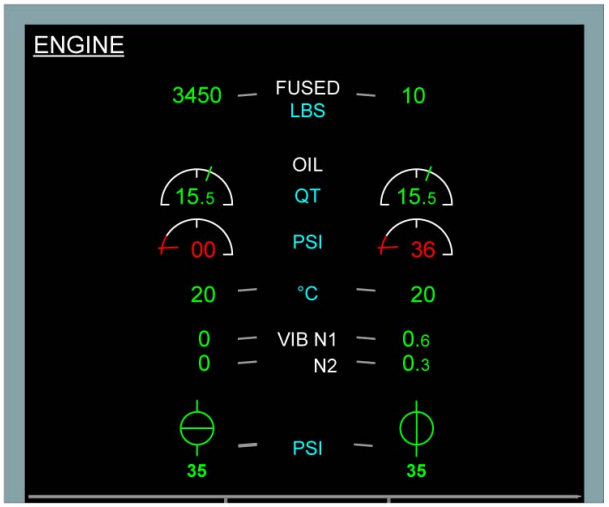
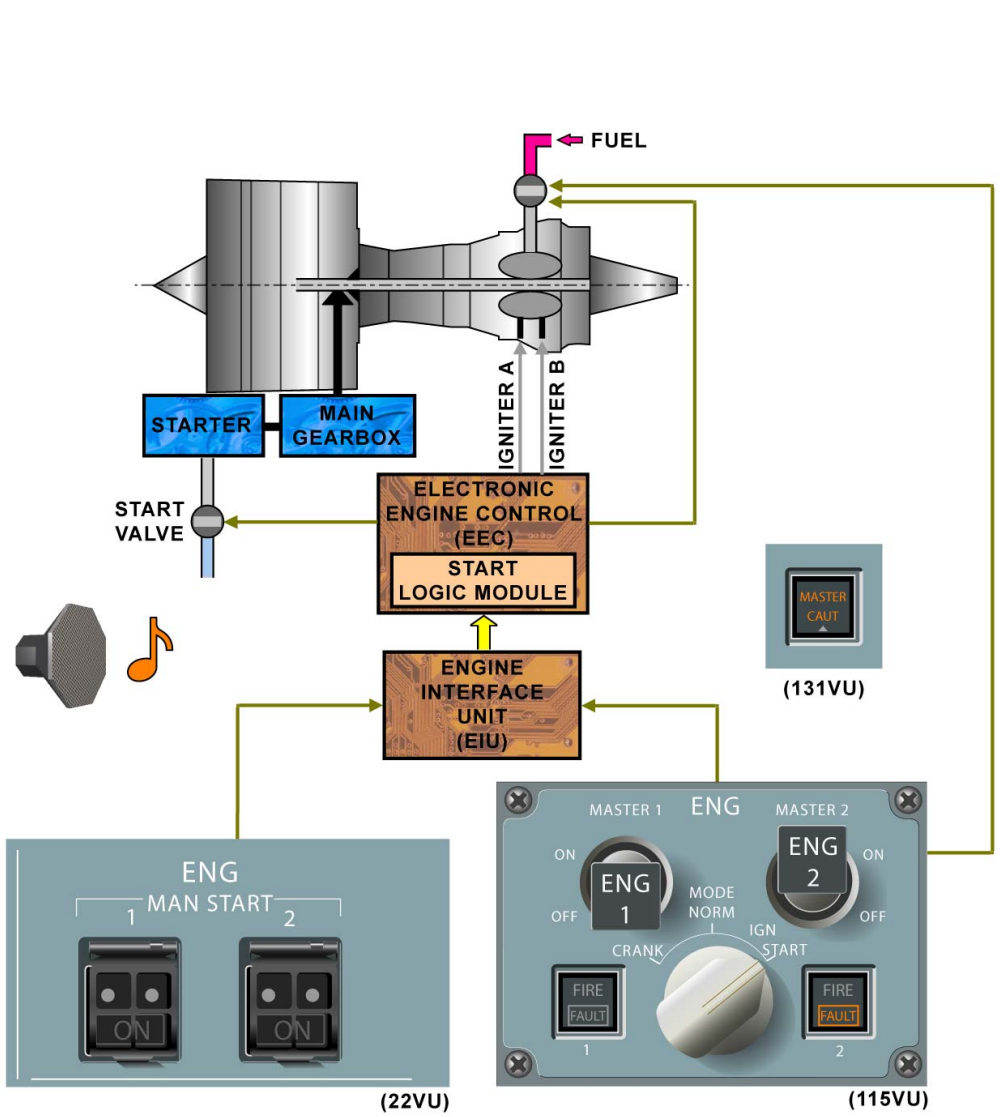
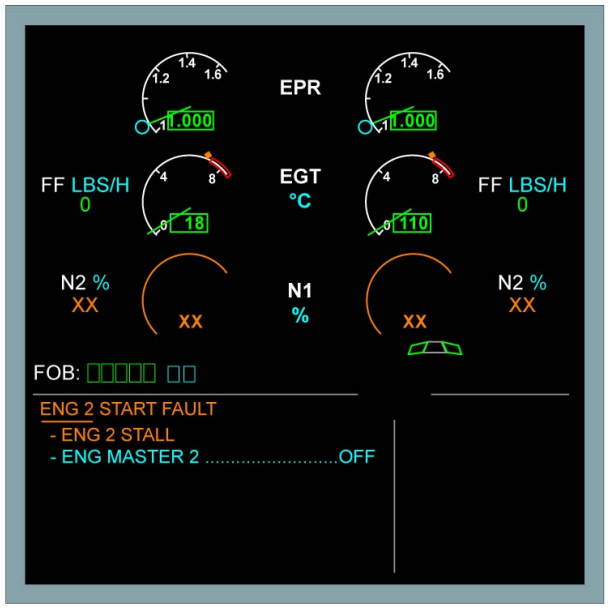


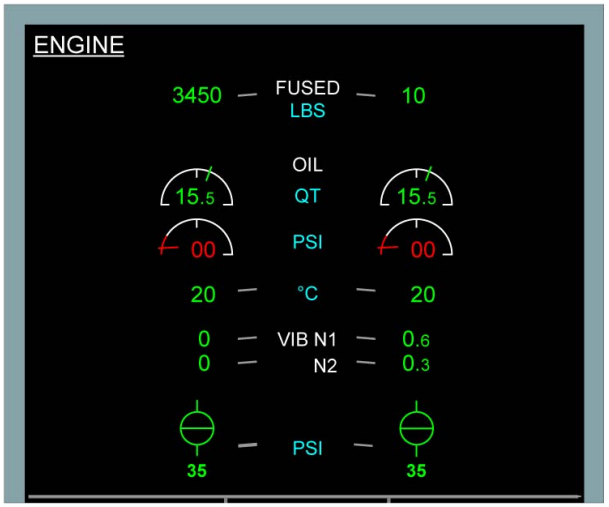




START FAULT (STALL AUTOMATIC MODE)







START FAULT (STALL AUTOMATIC MODE)

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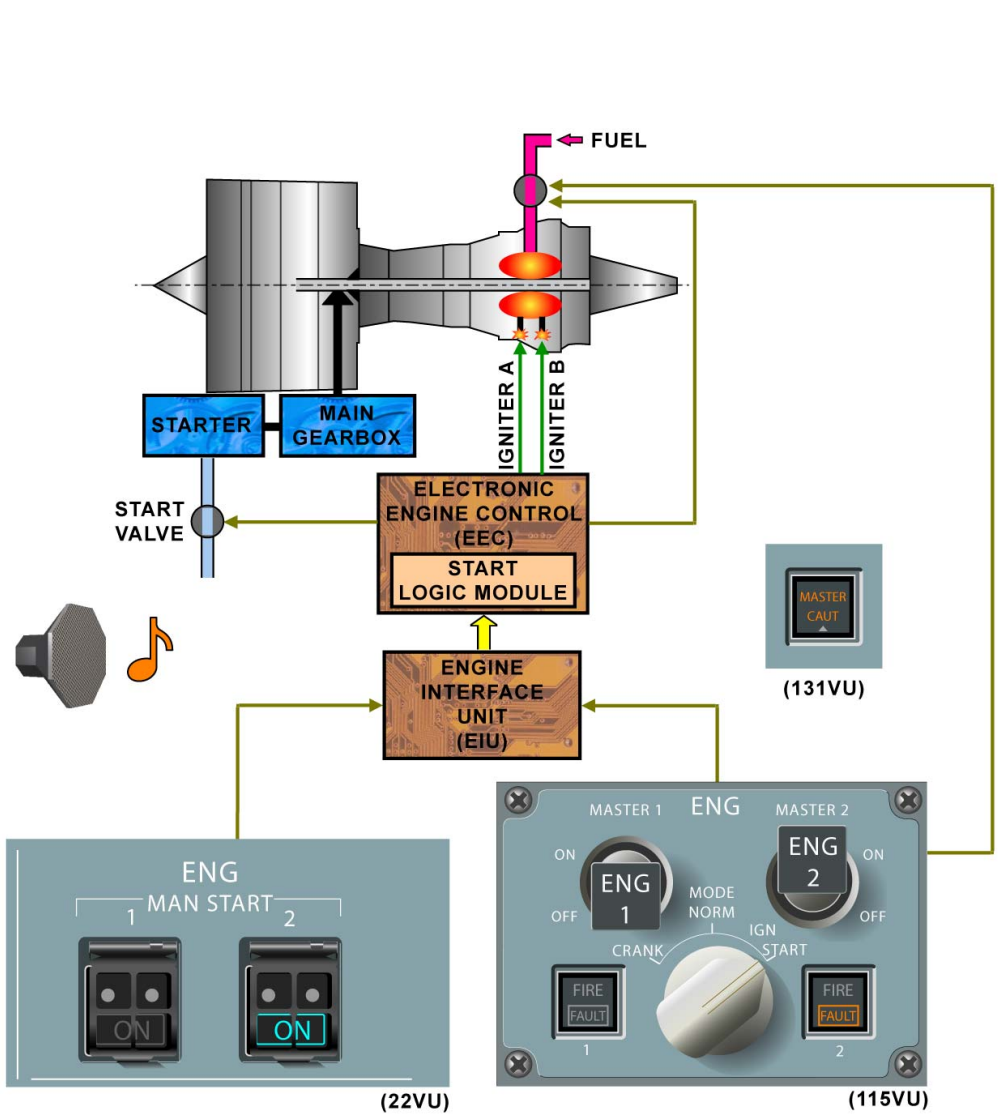
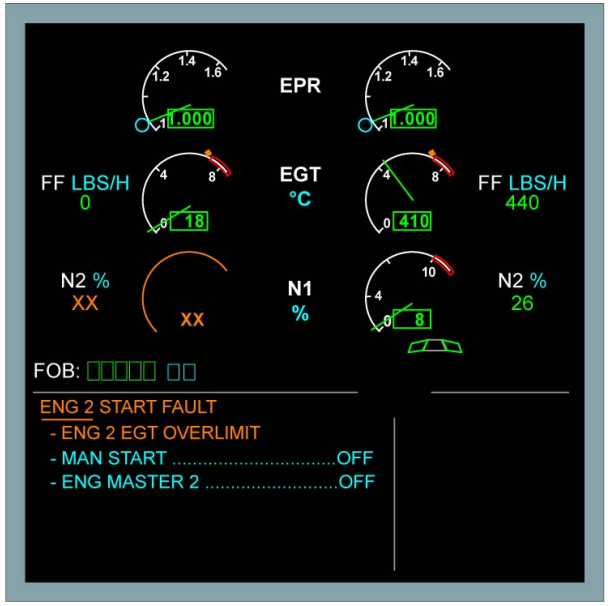
START FAILURES (US) (3)

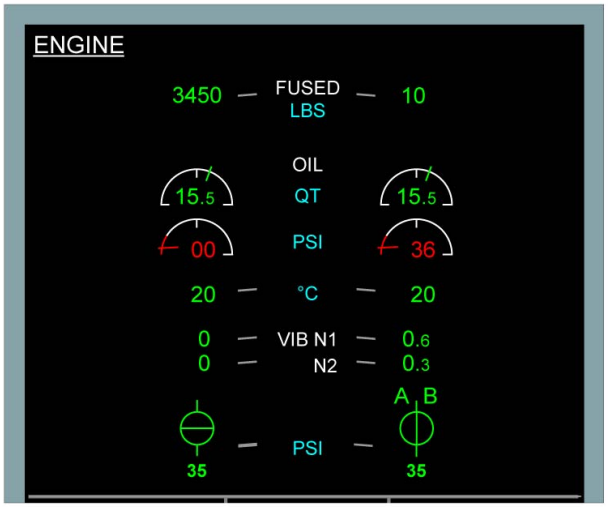
START FAULT (FAILURE DURING ENG MANUAL START MODE)

During the start, in case of EGT exceedance, an aural warning is triggered. The MASTER CAUT and the ENG FAULT lights come on. An ECAM message comes into view. In manual start, the FADEC does not abort the start.
The Crew operates the MASTER LEVER switch to OFF to stop the engine, as per ECAM procedure.

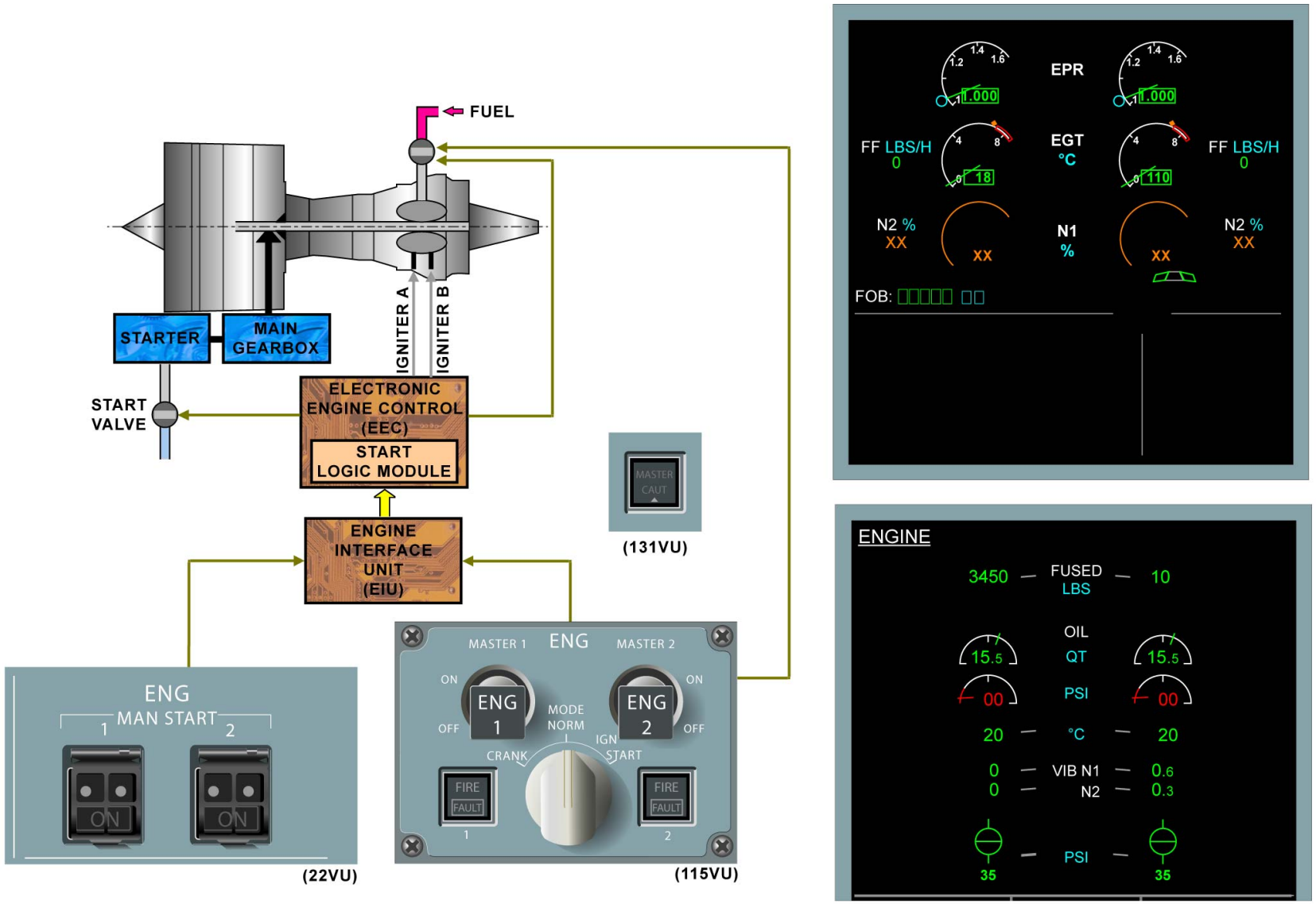
UGB13131 - U64T2M0 - UM74D2IAE000004







START FAULT (FAILURE DURING ENG MANUAL START MODE)



START FAULT (FAILURE DURING ENG MANUAL START MODE)

EWD: FAILURE TITLE CONDITIONS	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNINGS
START VALVE (NOT OPEN)	SINGLE CHIME	MASTER CAUT	ENG	ENG FAULT LT
START VALVE (NOT CLOSED)				
START FAULT (IGNITION AUTOMATIC MODE)				
START FAULT (IGNITION MANUAL MODE)				
START FAULT (STALL AUTOMATIC MODE)				
START FAULT (EGT OVERLIMIT MANUAL MODE)				

START FAULT (FAILURE DURING ENG MANUAL START MODE)

ENGINE THRUST MANAGEMENT (3)

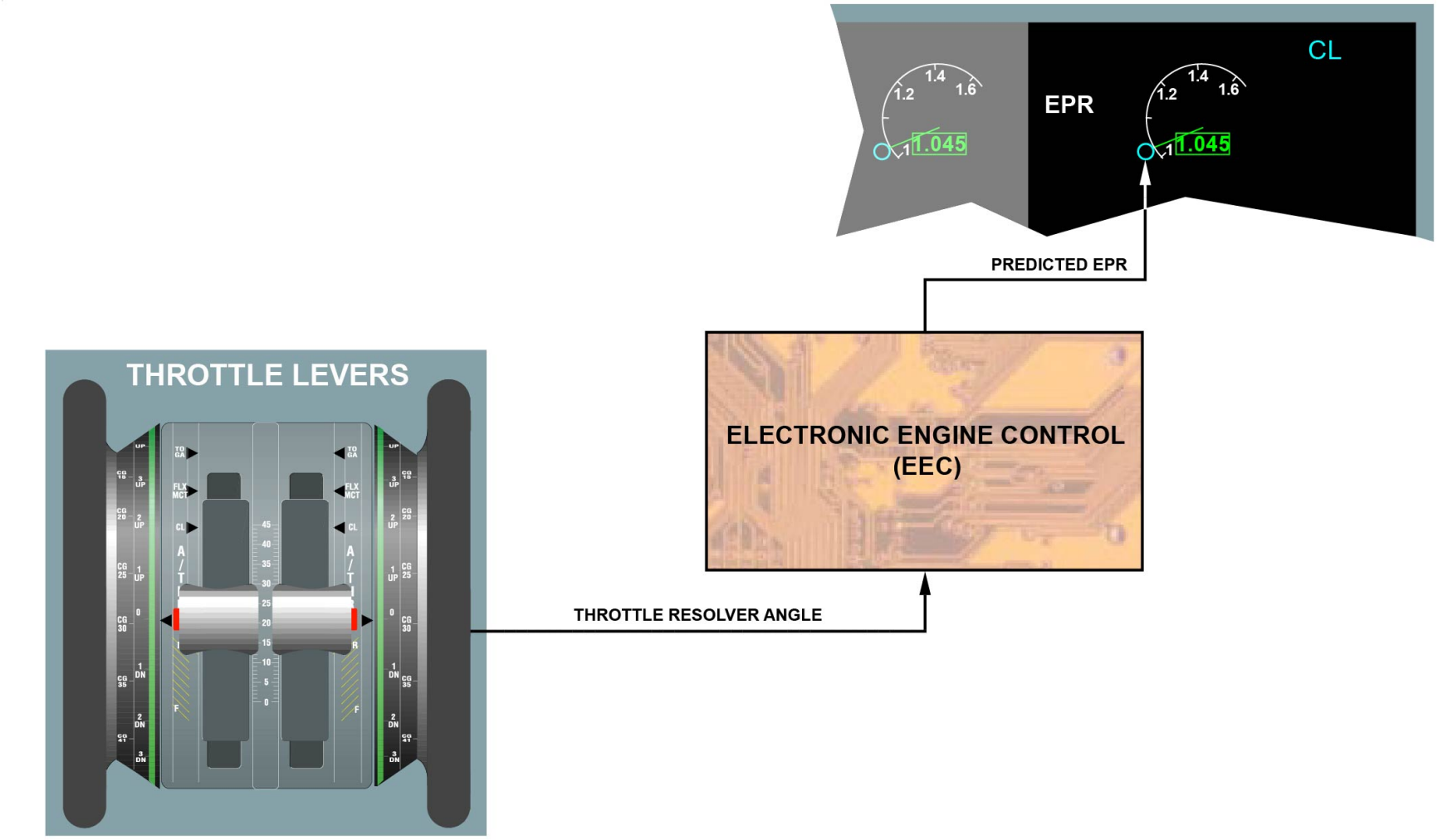
BASIC INFORMATION

Some basic information about engine thrust management is shown in this module.

PREDICTED EPR

The predicted Engine Pressure Ratio (EPR) is indicated by a cyan circle on the EPR indicator and corresponds to the value determined by the Throttle Resolver Angle (TRA).

UGB13131 - U64T2M0 - UM76D11AE000002



BASIC INFORMATION - PREDICTED EPR

ENGINE THRUST MANAGEMENT (3)

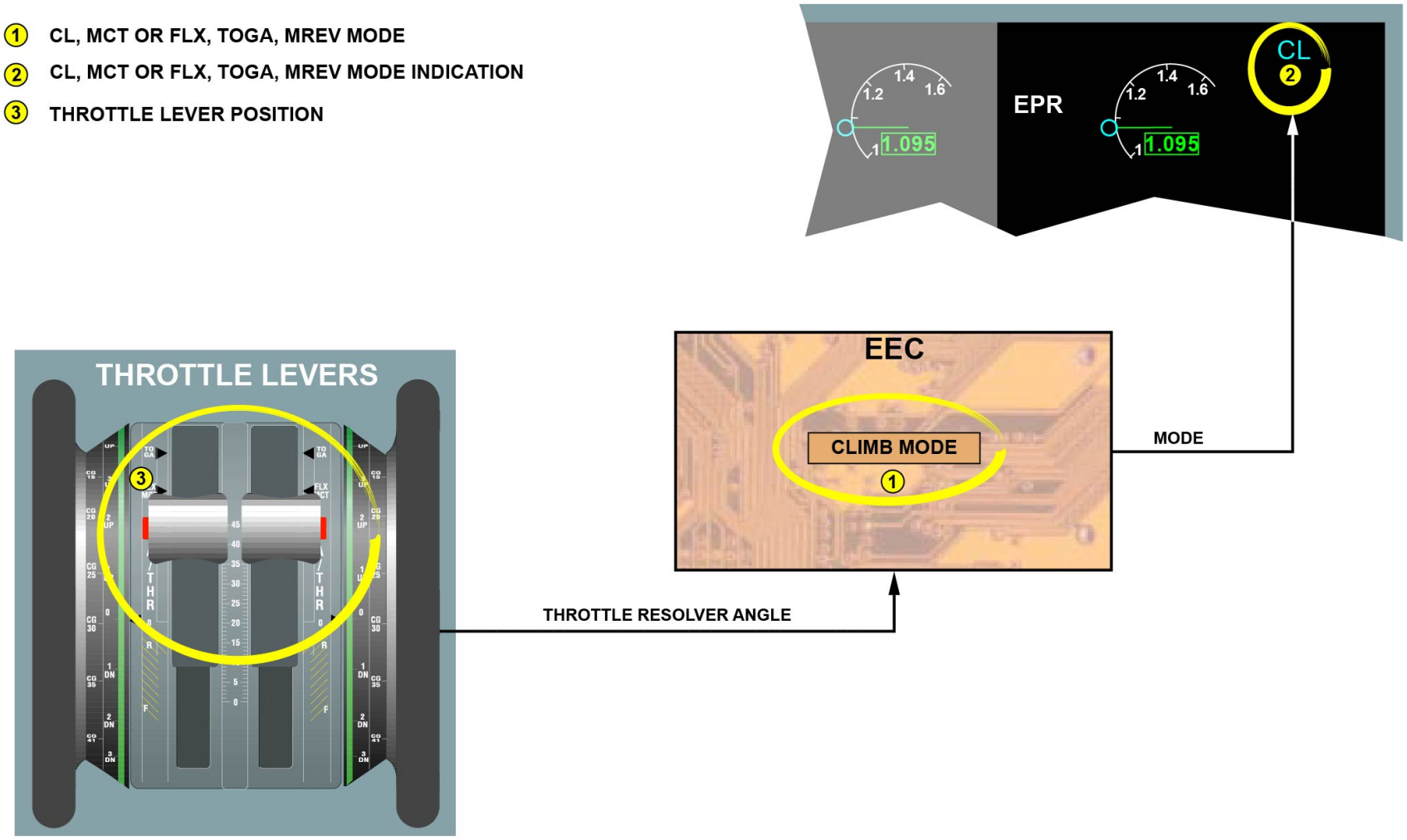
BASIC INFORMATION (continued)

THRUST LIMIT MODES

The throttle levers are used as thrust limit mode selectors. Depending on the throttle lever position, a thrust limit mode is selected and appears on the upper ECAM display. If the throttle levers are set between two detent points, the upper detent will determine the thrust limit mode. The thrust limit modes are:

- CL: Climb,
- FLX: Flexible take-off,
- MCT: Maximum Continuous Thrust,
- TOGA: Take Off/Go Around.
- MREV: Maximum Reverser

1. CL, MCT OR FLX, TOGA, MREV MODE
2. CL, MCT OR FLX, TOGA, MREV MODE INDICATION
3. THROTTLE LEVER POSITION



EEC: ELECTRONIC ENGINE CONTROL

BASIC INFORMATION - THRUST LIMIT MODES

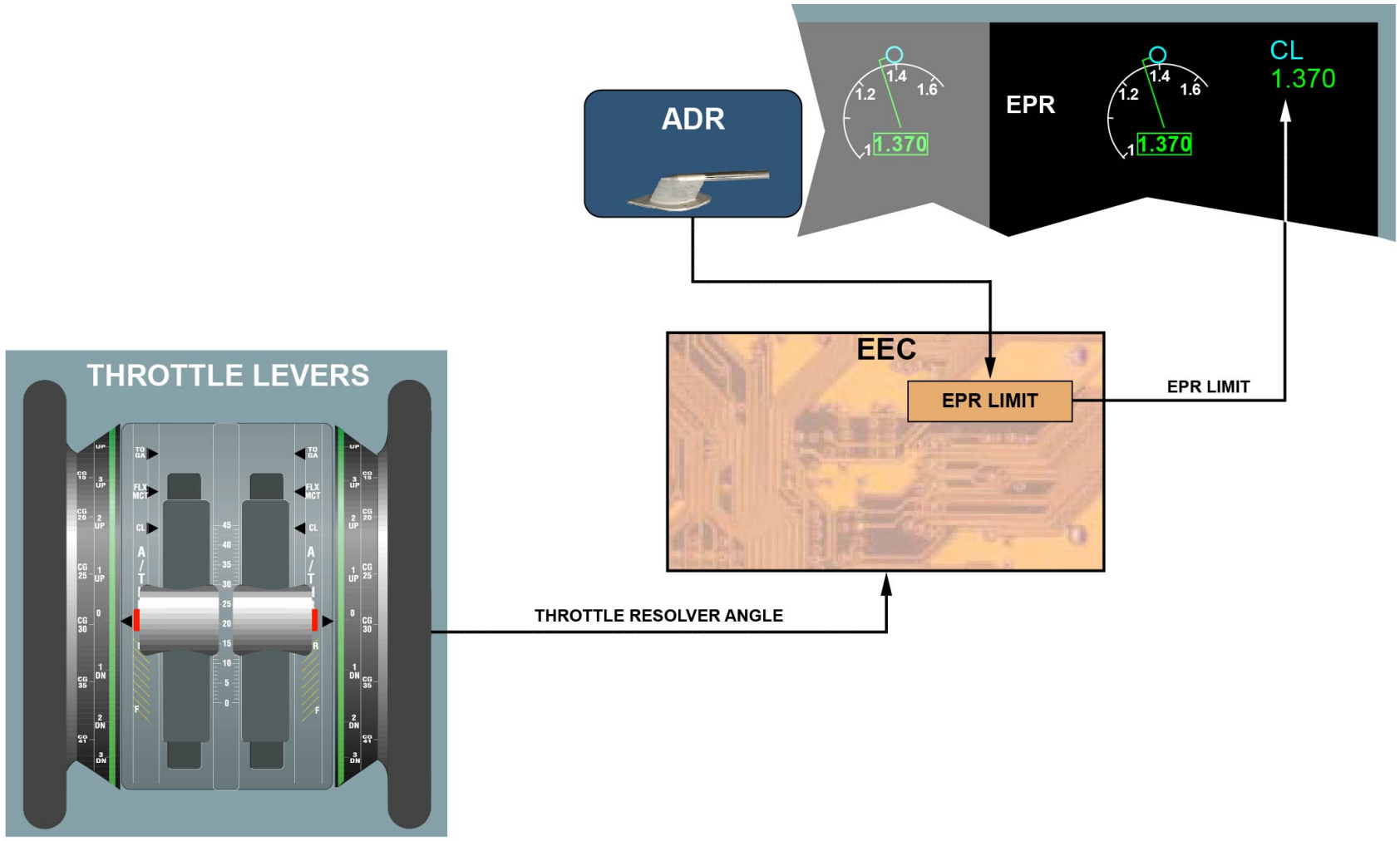
ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

EPR LIMIT

For each thrust limit mode selection, an EPR limit is computed according to the Air Data Reference (ADR) and appears on the upper ECAM display beside the thrust limit mode indication.

UGB13131 - U64T2M0 - UM76D1IAE000002



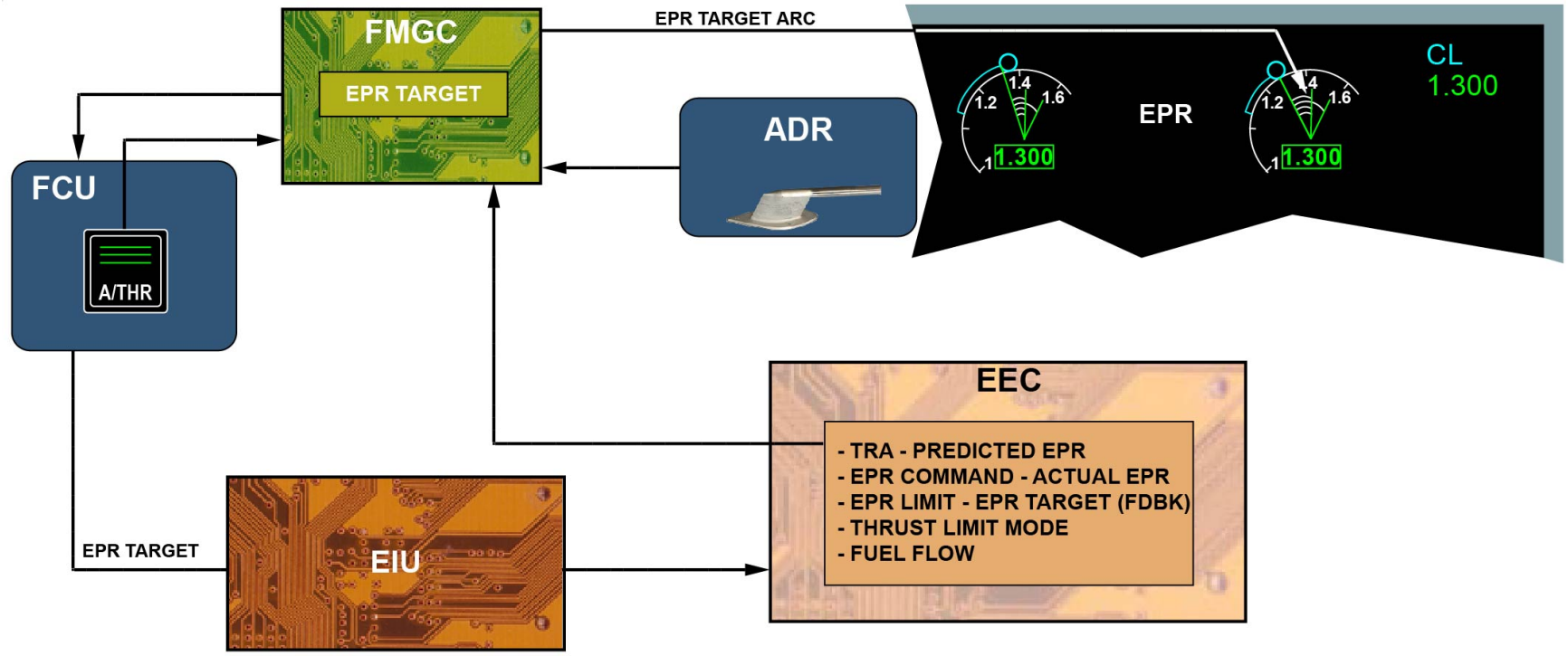
BASIC INFORMATION - EPR LIMIT

ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

EPR TARGET

For its auto thrust function, the Flight Management and Guidance System (FMGS) computes an EPR target according to ADR and engine parameters and sends it to the Electronic Engine Control (EEC).



ADR: AIR DATA REFERENCE
EEC: ELECTRONIC ENGINE CONTROL
EPR: ENGINE PRESSURE RATIO
FCU: FLIGHT CONTROL UNIT
FMGC: FLIGHT MANAGEMENT AND GUIDANCE COMPUTER

BASIC INFORMATION - EPR TARGET

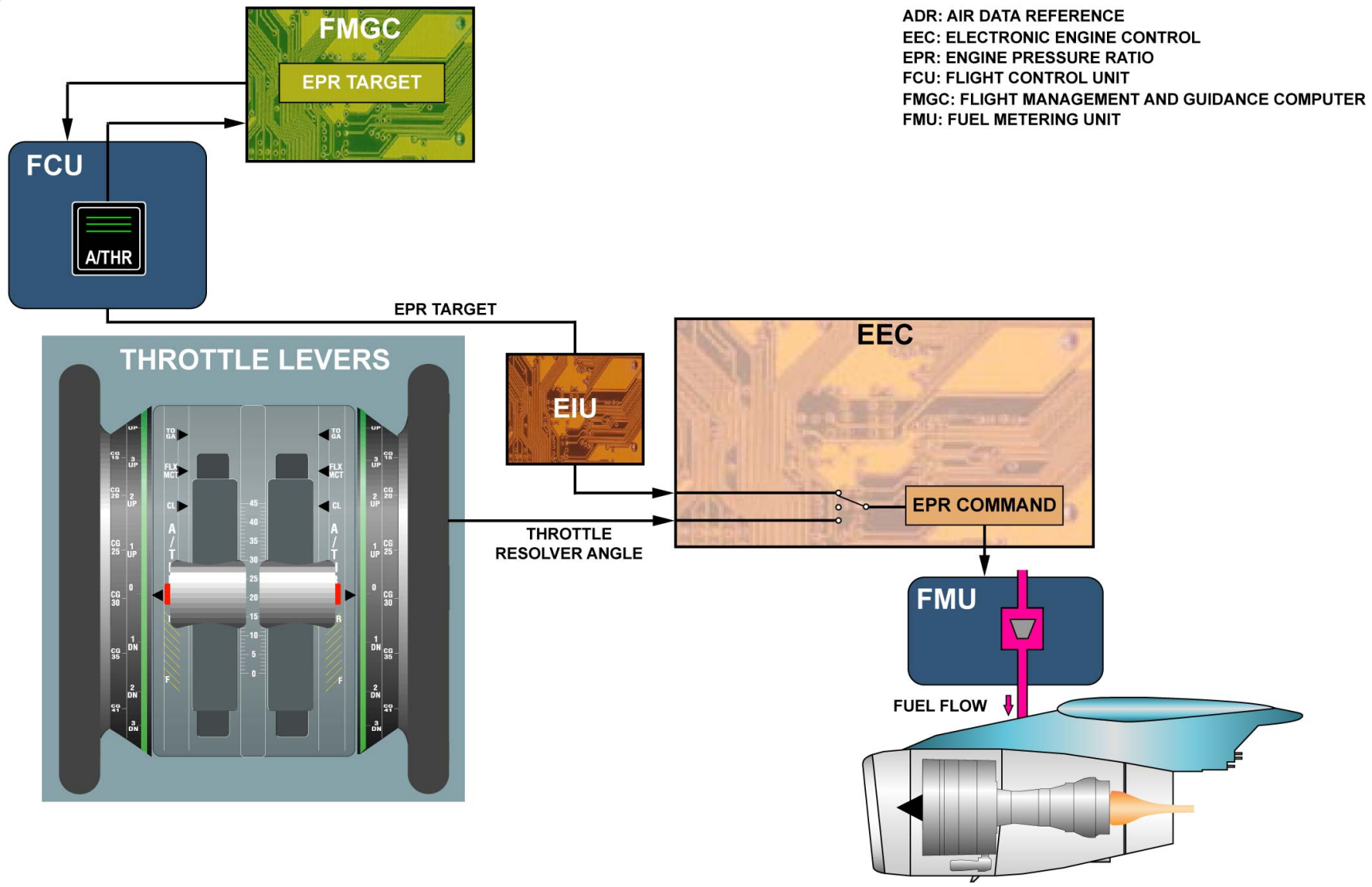
ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

EPR COMMAND

The EPR command, used to regulate the fuel flow, is the Flight Management and Guidance Computer (FMGC) EPR target when the auto thrust function is active. When the auto thrust function is not active, the EPR command is the EPR corresponding to the TRA. EPR command is either:

- EPR target,
- EPR corresponding to TRA.



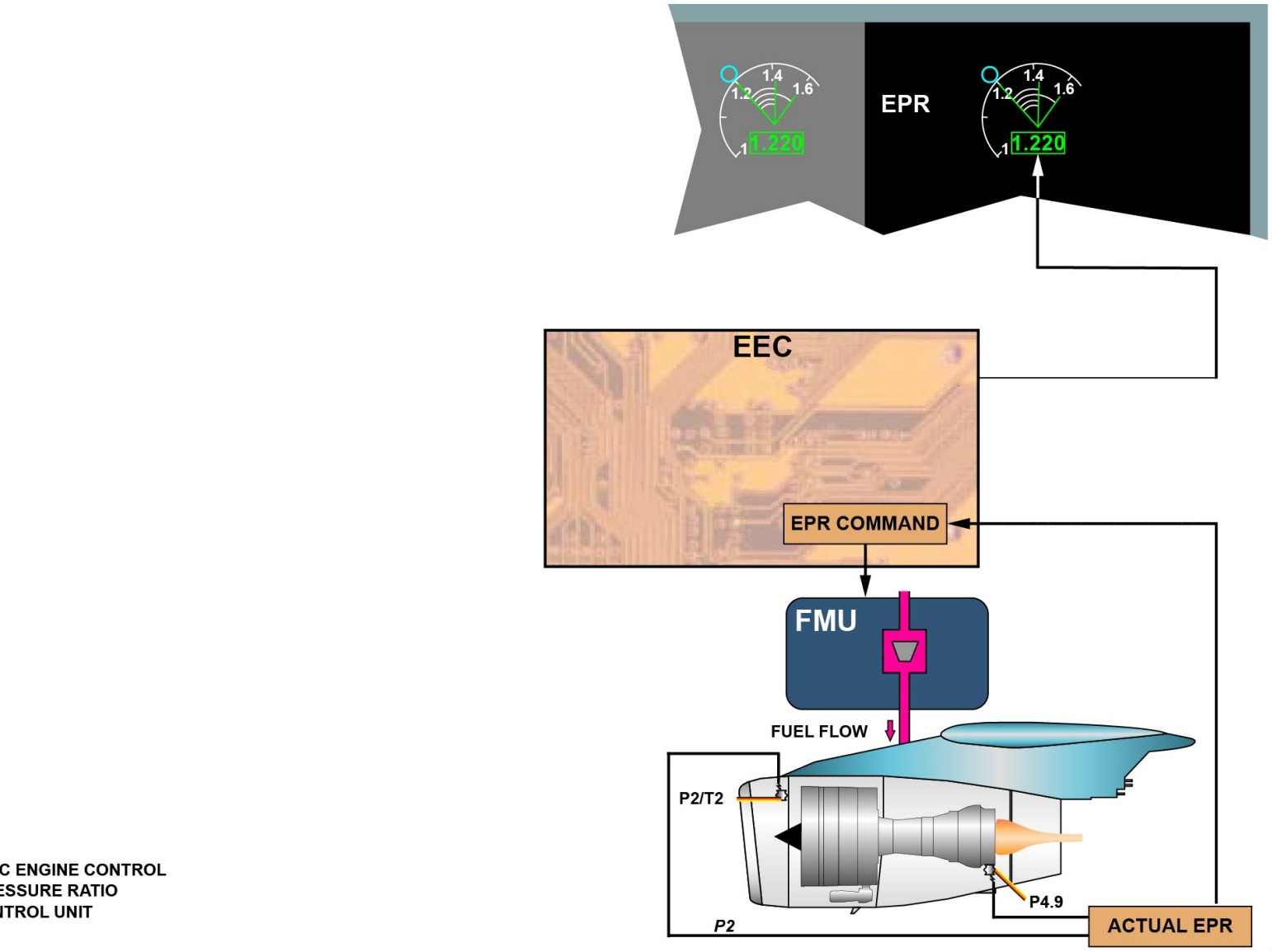
BASIC INFORMATION - EPR COMMAND

ENGINE THRUST MANAGEMENT (3)

BASIC INFORMATION (continued)

ACTUAL EPR

The actual EPR is the actual value given by the ratio of the LP turbine exhaust pressure (P4.9) to the engine inlet pressure (P2). The actual EPR is displayed in green on the EPR indicator. The actual EPR signal is also compared to the EPR command.



EEC: ELECTRONIC ENGINE CONTROL
EPR: ENGINE PRESSURE RATIO
FCU: FLIGHT CONTROL UNIT

BASIC INFORMATION - ACTUAL EPR

ENGINE THRUST MANAGEMENT (3)

AUTOTHRUST CONTROL MODE

The auto thrust function is engaged when the A/THR P/B is on. The auto thrust engages:
- when the A/THR P/B is pressed in,
- at take-off power application.

AUTOTHRUST ACTIVE

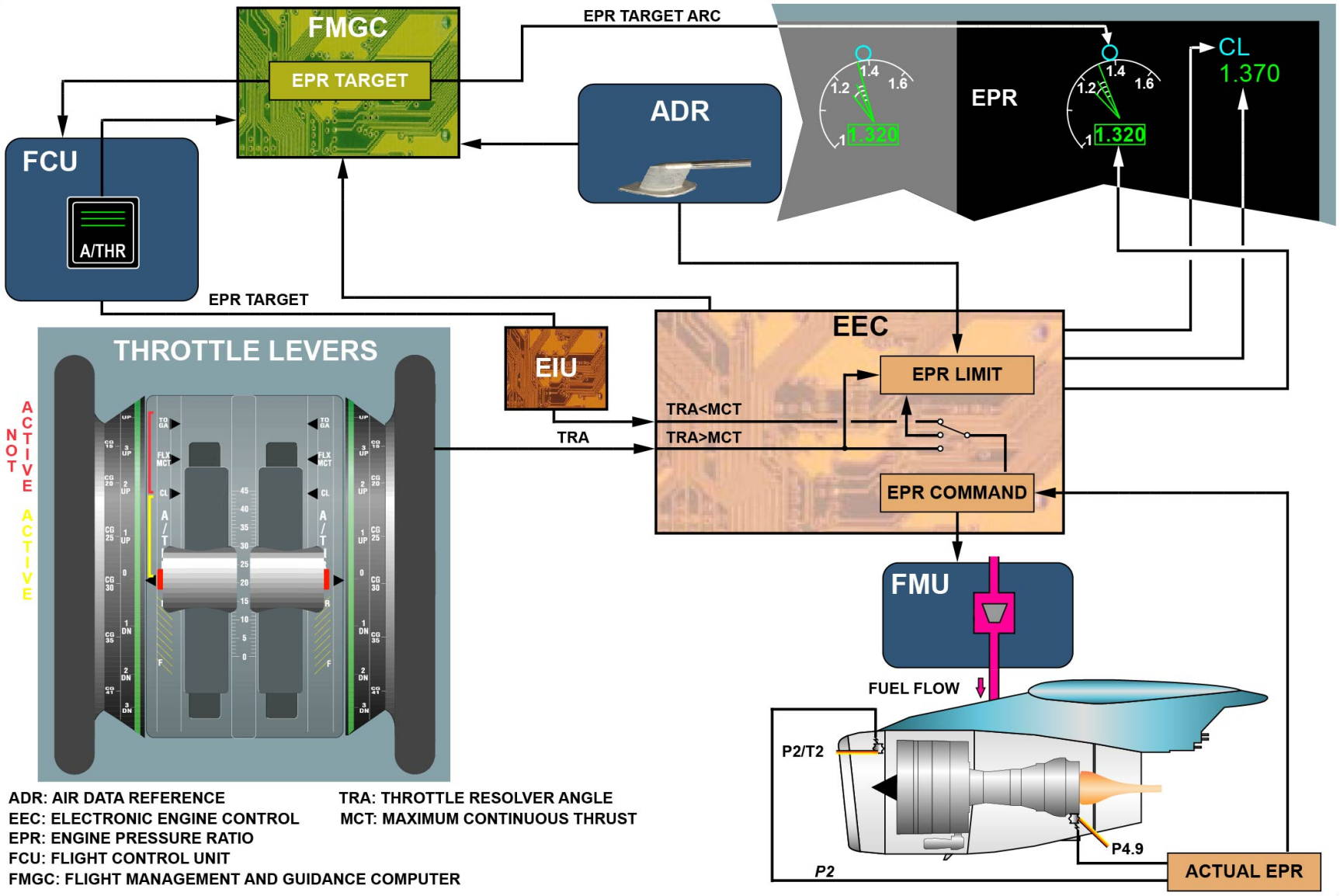
When engaged, the auto thrust function becomes active when the throttle levers are set to the Climb detent after take-off. The EPR command is the FMGC EPR target. The auto thrust function is active when the throttle levers are set between IDLE and CL, including CL, with 2 engines running.

NOTE: The auto thrust function active range is extended to MCT in the case of single engine operation.

When the throttle levers are set between two detent points, the EPR command is limited by the throttle lever position.

NOTE: In alpha floor condition the auto thrust function becomes active automatically. The EPR target is TOGA.

UGB13131 - U64T2M0 - UM76D1IAE000002



AUTOTHRUST CONTROL MODE - AUTOTHRUST ACTIVE

ENGINE THRUST MANAGEMENT (3)

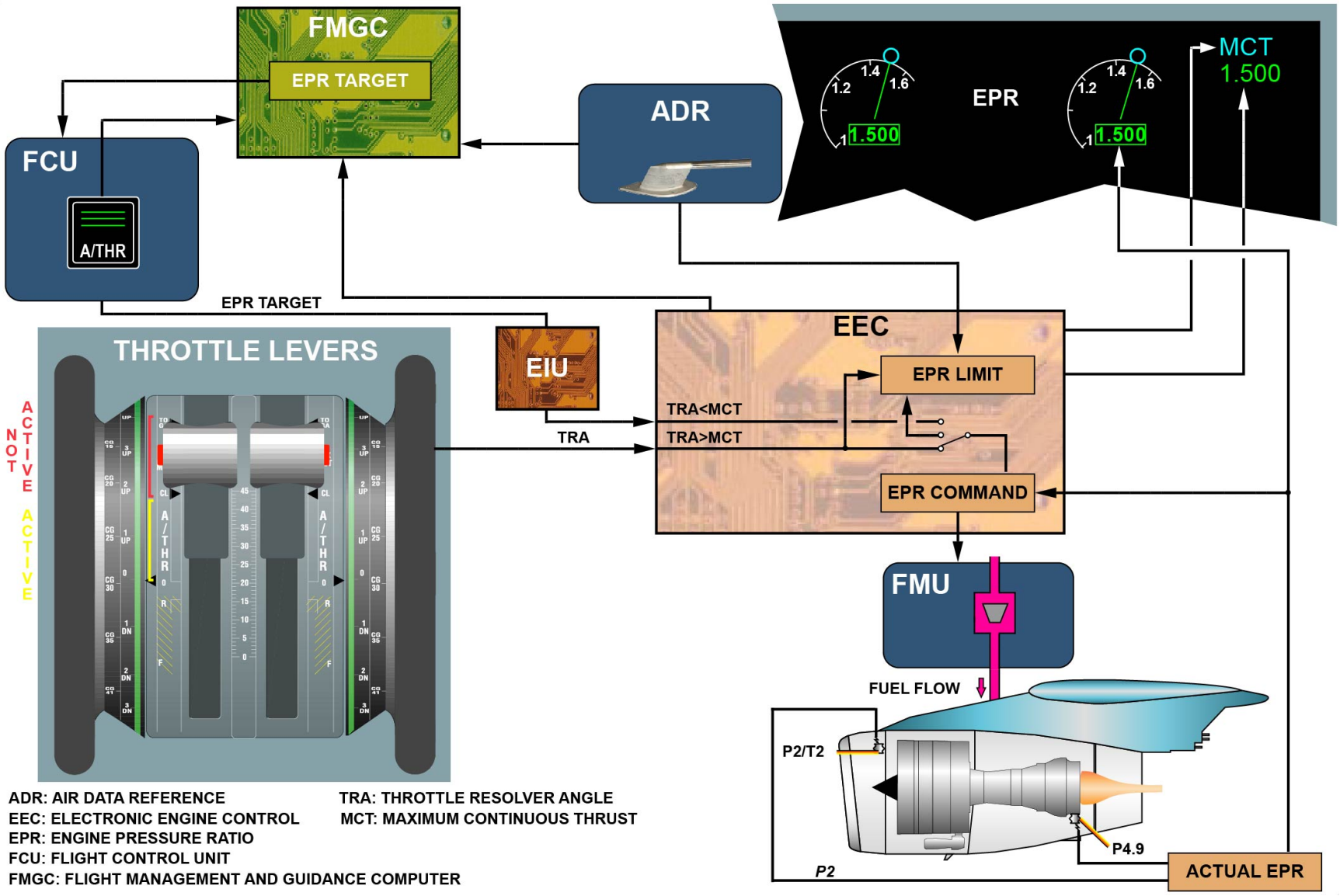
AUTOTHRUST CONTROL MODE (continued)

AUTOTHRUST NOT ACTIVE

When engaged, the auto thrust function becomes inactive when the throttle levers are set above CL with 2 engines running. The EPR command corresponds to the TRA.

NOTE: The auto thrust function is not active above MCT in case of single engine operation.

The auto thrust function is disengaged when the throttle levers are set at the IDLE stop.

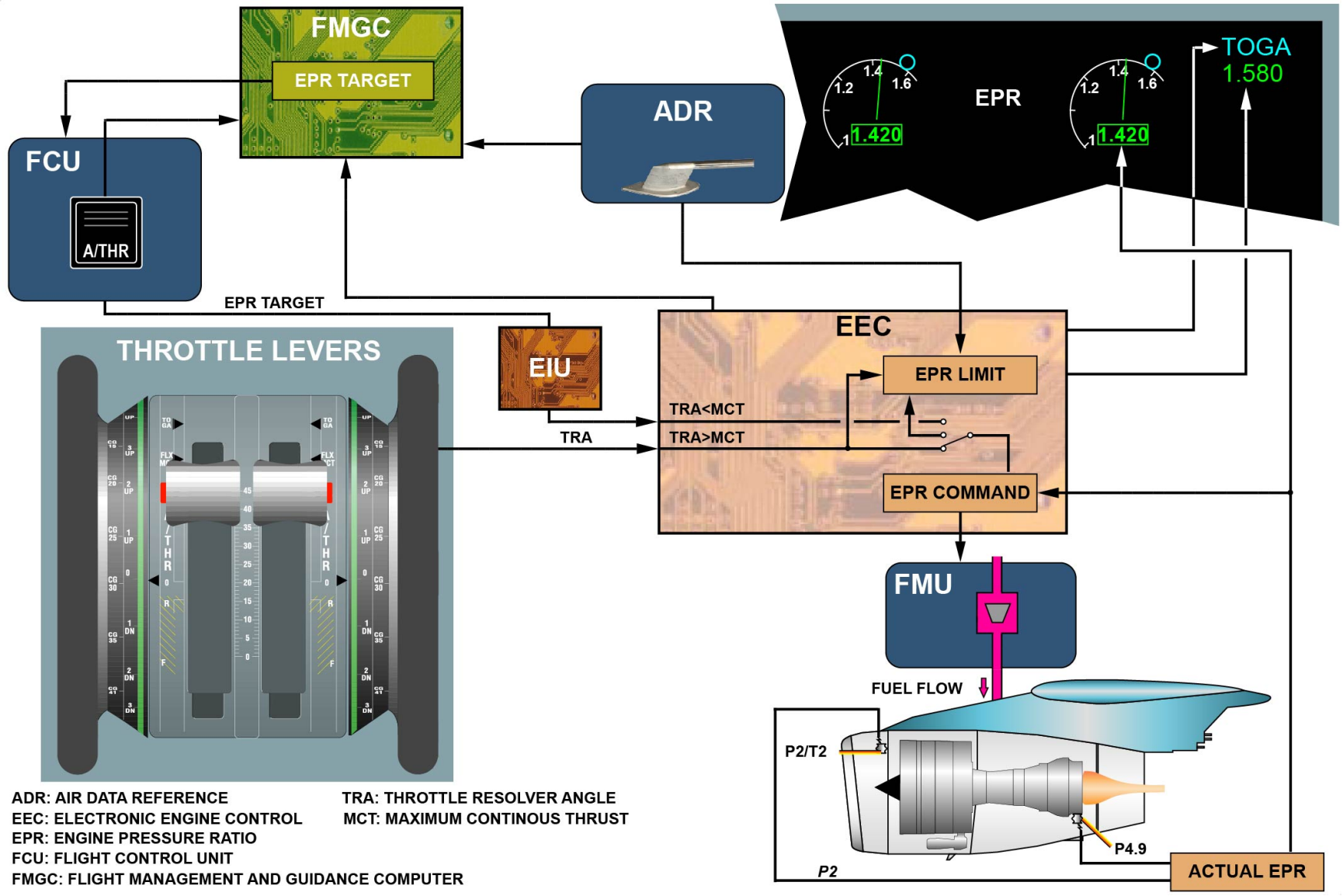


AUTOTHRUST CONTROL MODE - AUTOTHRUST NOT ACTIVE

ENGINE THRUST MANAGEMENT (3)

MANUAL CONTROL MODE

When the auto thrust function is not engaged, the EEC processes the EPR command signal according to the TRA. In manual mode the auto thrust is not engaged.



MANUAL CONTROL MODE

ENGINE THRUST MANAGEMENT (3)

BACK-UP N1 MODE

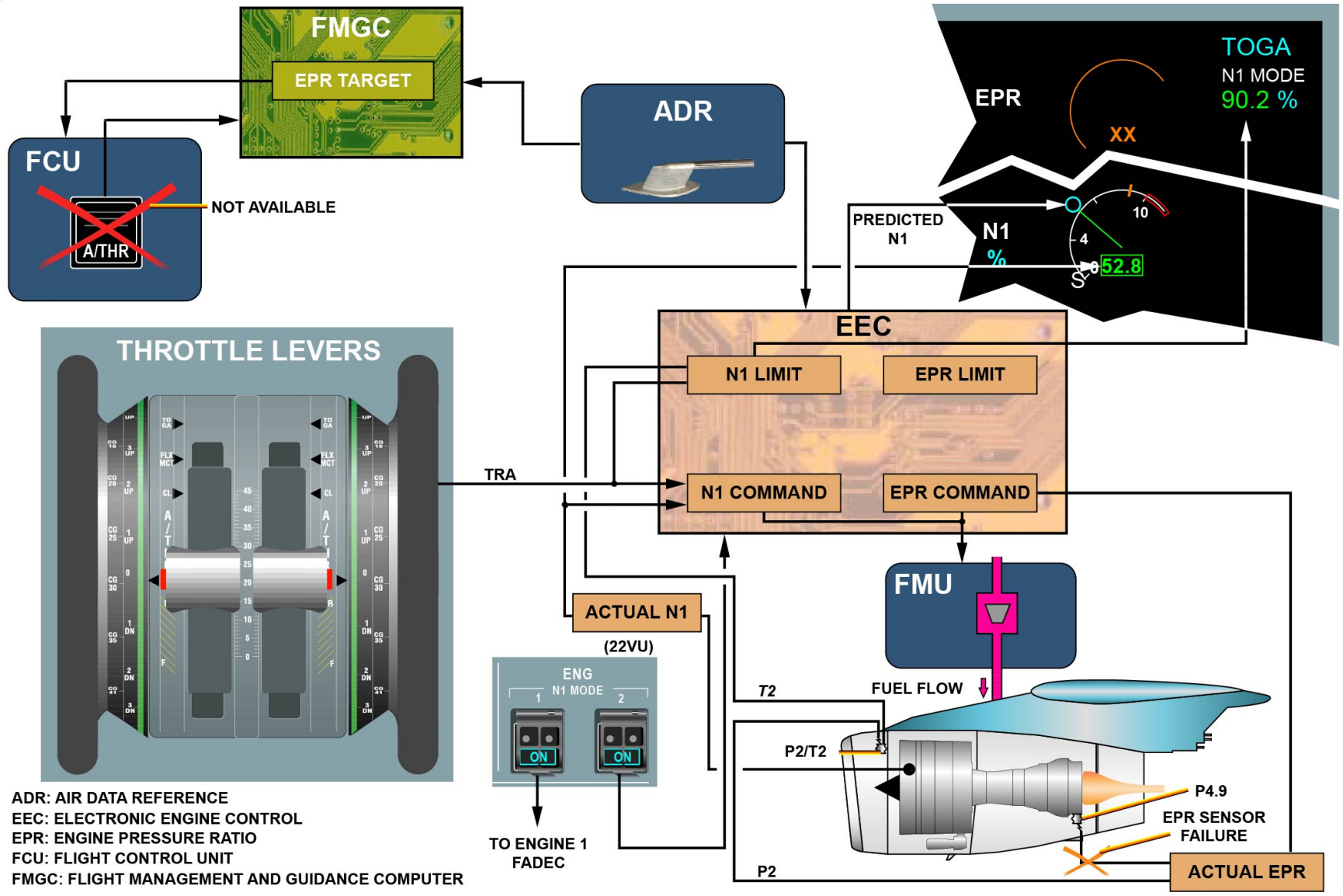
Here are presented two back-up N1 modes:
- rated N1 mode,
- unrated N1 mode.

RATED N1 MODE

In case of EPR sensor failure, i.e. P2 or P4.9, the EEC automatically reverts to the rated N1 mode. On the ECAM, the EPR indicator is crossed amber. The EEC uses TLA, ADR and T2. T2 is used in N1 rated mode to limit the engine thrust. To select N1 mode on both engines, the Engine N1 MODE P/Bs must be pressed in.

NOTE: The auto thrust function is not available in N1 mode. When the N1 MODE P/Bs are pressed in, the lights come ON and a signal is sent to their corresponding Full Authority Digital Engine Control (FADEC) system to confirm or to force the N1 MODE selection. On the ECAM, the EPR indicator is crossed amber and the N1 MODE limit is displayed instead of the EPR limit. On the N1 indicator, the predicted N1, i.e. the cyan circle, replaces the predicted EPR and an amber index appears to indicate the take-off N1 limit.

UGB13131 - U64T2M0 - UM76D1IAE000002



BACK-UP N1 MODE - RATED N1 MODE

ENGINE THRUST MANAGEMENT (3)

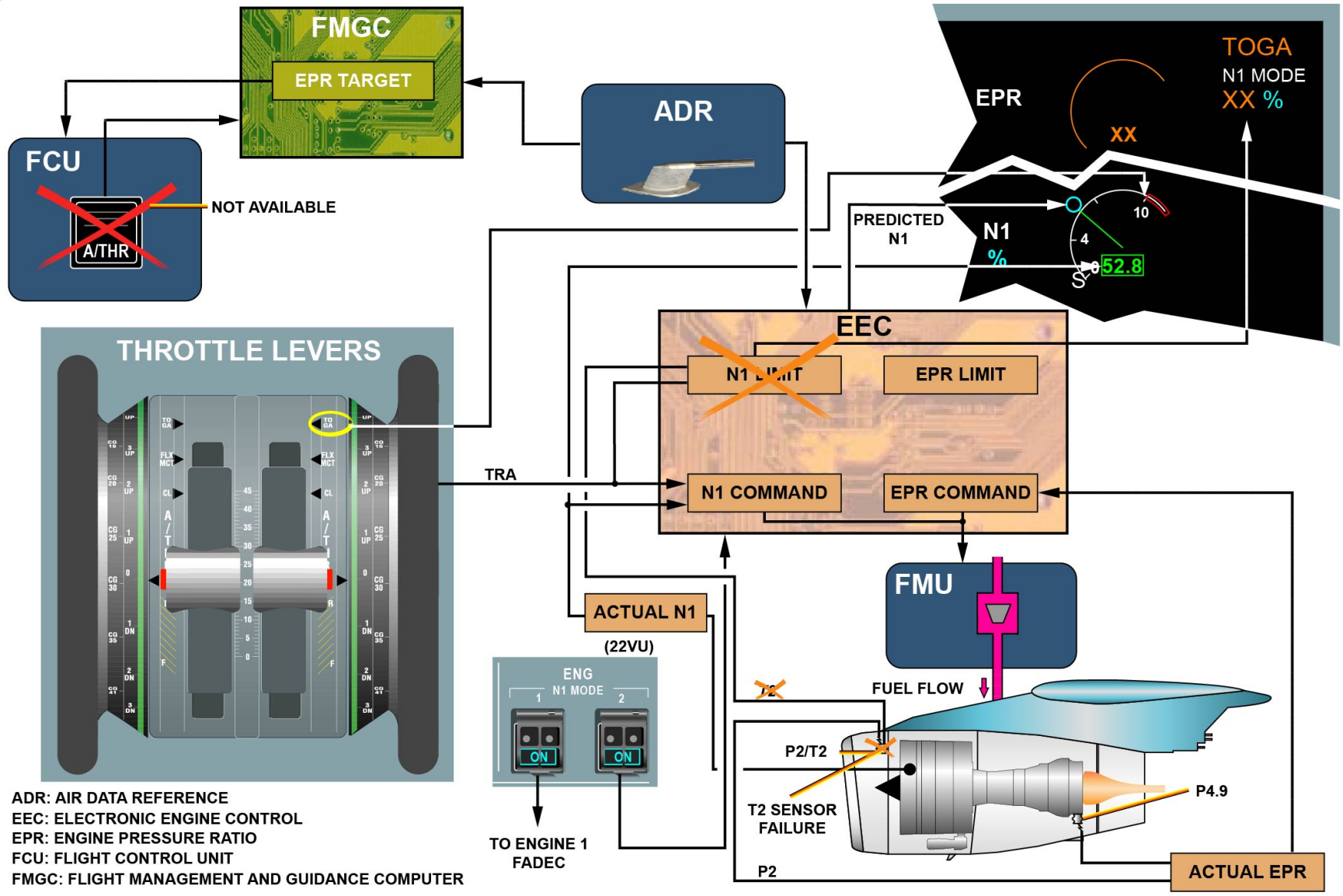
BACK-UP N1 MODE (continued)

UNRATED N1 MODE

T2 is no longer available; the EEC reverts from the EPR mode to the unrated N1 mode. In this case the N1 limitation is no longer computed. The N1 command is directly related to the TRA.

NOTE: in unrated N1 mode, there is no longer an engine protection against over boost, e.g. Go-Around.

UGB13131 - U64T2M0 - UM76D11AE000002



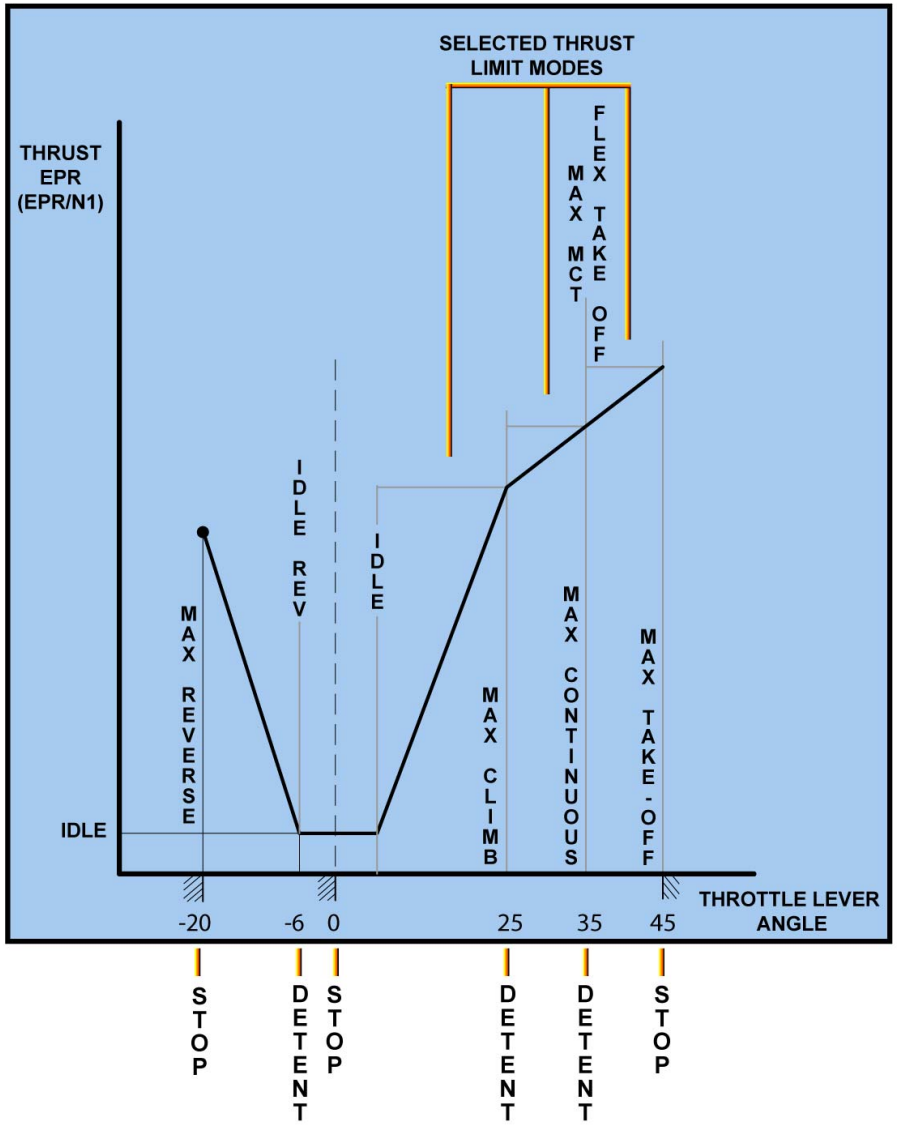
BACK-UP N1 MODE - UNRATED N1 MODE

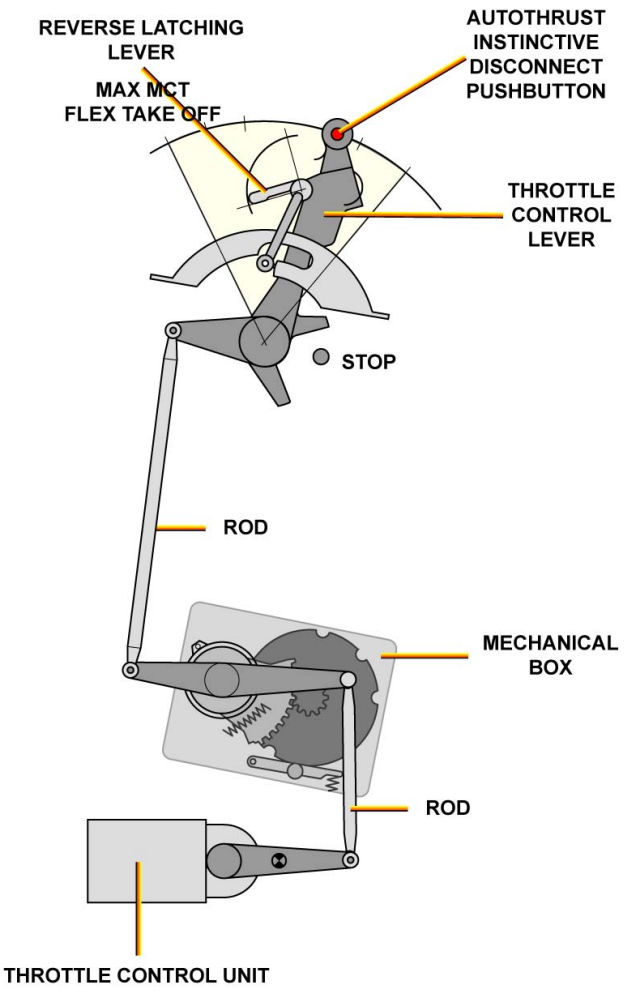
UGB13131 - U64T2M0 - UM76D1IAE000002

THROTTLE CONTROL SYSTEM D/O (3)

THROTTLE CONTROL LEVER

The Throttle control handle comprises:
o a throttle control lever which incorporates stop devices, autothrust instinctive disconnect pushbutton switch
o a graduated fixed sector
o a reverse latching lever.
The throttle control lever is linked to a mechanical rod. This rod drives the input lever of the throttle control artificial feel unit.
The throttle control lever moves over a range from -20 deg. TLA (Reverser Full Throttle stop) to +45 deg. TLA:
o -20 degrees TLA corresponds to Reverser Full Throttle stop
o +45 degrees TLA corresponds to Forward Full Throttle stop
An intermediate mechanical stop is set to 0 deg.TLA. This stop is overridden when the reverse latching lever is pulled up for selection of the reverse power. This stop is reset as soon as the throttle control lever is selected back to forward thrust area.
In the forward thrust area, there are two detent points, the MAX CLIMB detent point set to 25 deg.TLA and the MAX CONTINUOUS/FLEX TAKE-OFF detent point set to 35 deg.TLA.
In the reverse thrust throttle range, there is one detent point at - 6 deg.TLA. This position agrees with the selection of the thrust reverser command and the Reverse Idle setting.
In the middle throttle range (0deg. To 35 deg.TLA), the autothrust function can be active if engaged. This range agrees with the selection of MAX CLIMB or MAX CONTINUOUS thrust limit mode (in single operation). If the autothrust is not engaged, the engine control is manual.
In the forward range (35 deg. To 45 deg.TLA), the autothrust function cannot be activated (except in alpha floor condition).This range agrees with the selection of FLEX TAKE-OFF/MAX TAKE-OFF Mode.



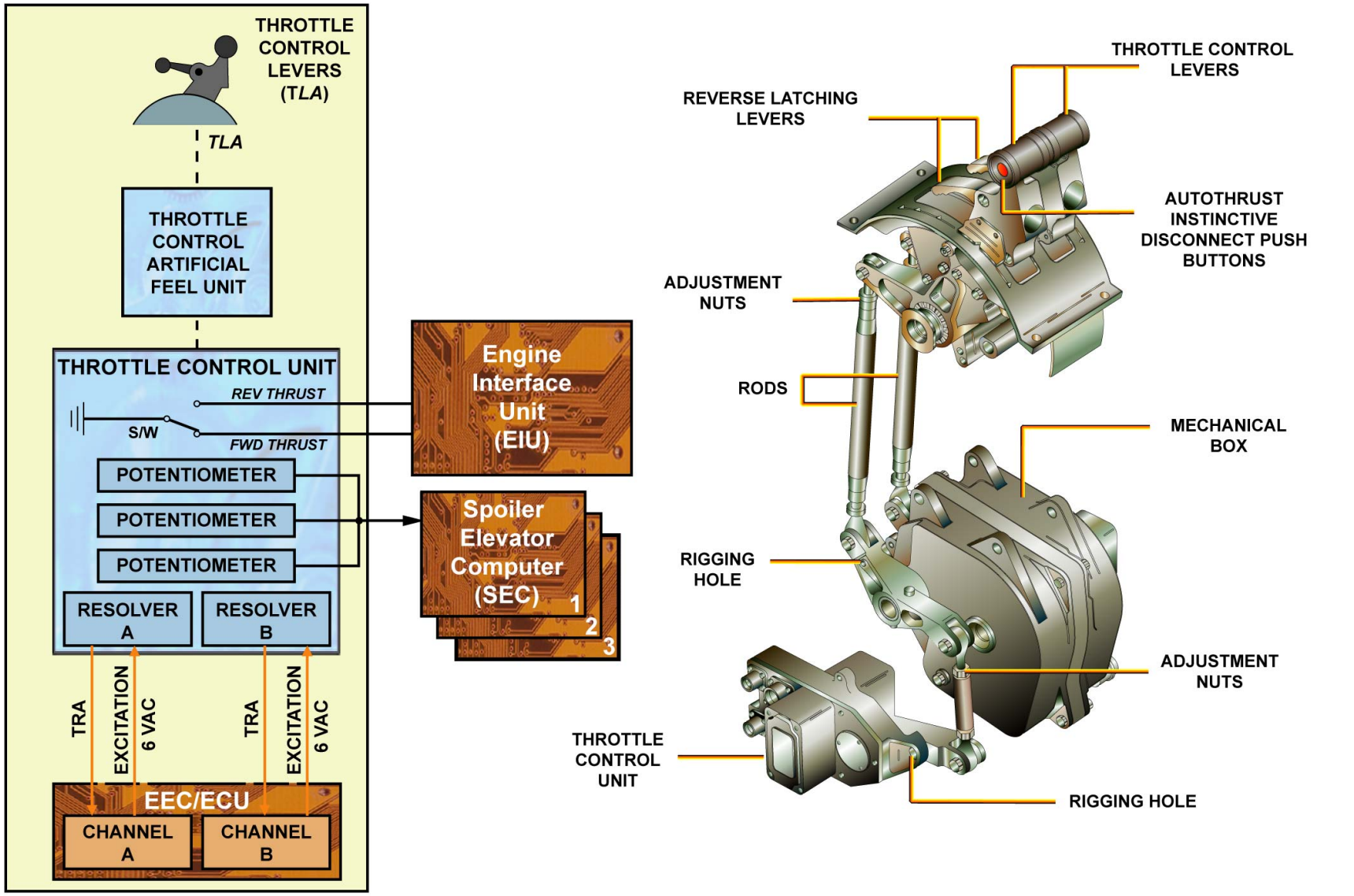


THROTTLE CONTROL LEVER

THROTTLE CONTROL SYSTEM D/O (3)

THROTTLE CONTROL UNIT

A mechanical rod transmits the throttle control lever movement. It connects the throttle artificial feel unit to the input lever of the throttle control unit. The throttle control unit comprises:
-An input lever
-Mechanical stops, which limit the angular range
-2 resolvers (one resolver per FADEC (ECU/EEC)
-6 potentiometers installed three by three
-A device, which drives the resolver and the potentiometer
-A pin device for rigging the resolver and potentiometers
-1 switch whose signal is dedicated to the EIU
-2 output electrical connectors
The input lever drives two gear sectors assembled face to face. Each sector drives itself a set of one resolver and three potentiometers. The relationship between the throttle lever angle and throttle resolver angle (TRA) IS LINEAR AND 1 DEG.TLA = 1.9 TRA. The accuracy of the throttle control unit (error between the input lever position and the resolver angle) is 0.5 deg.TRA. The maximum discrepancy between the signals generated by two resolvers is 0.25 deg.TRA.
The TLA resolver operates in two quadrants. The first quadrant is used for positive angles and the second quadrant for negative angles. Each resolver is dedicated to one FADEC channel (ECU / EEC) and receives its electrical excitation current (6 VAC) from the related FADEC channel (ECU / EEC)
The ECU considers a throttle resolver angle value:
o less than -47.5 deg.TRA
or
o greater than 98.8 deg.TRA as resolver position signal failure.
The ECU includes a resolver fault accommodation logic. This logic allows engine operation after a failure or a complete loss of the throttle resolver position signal.

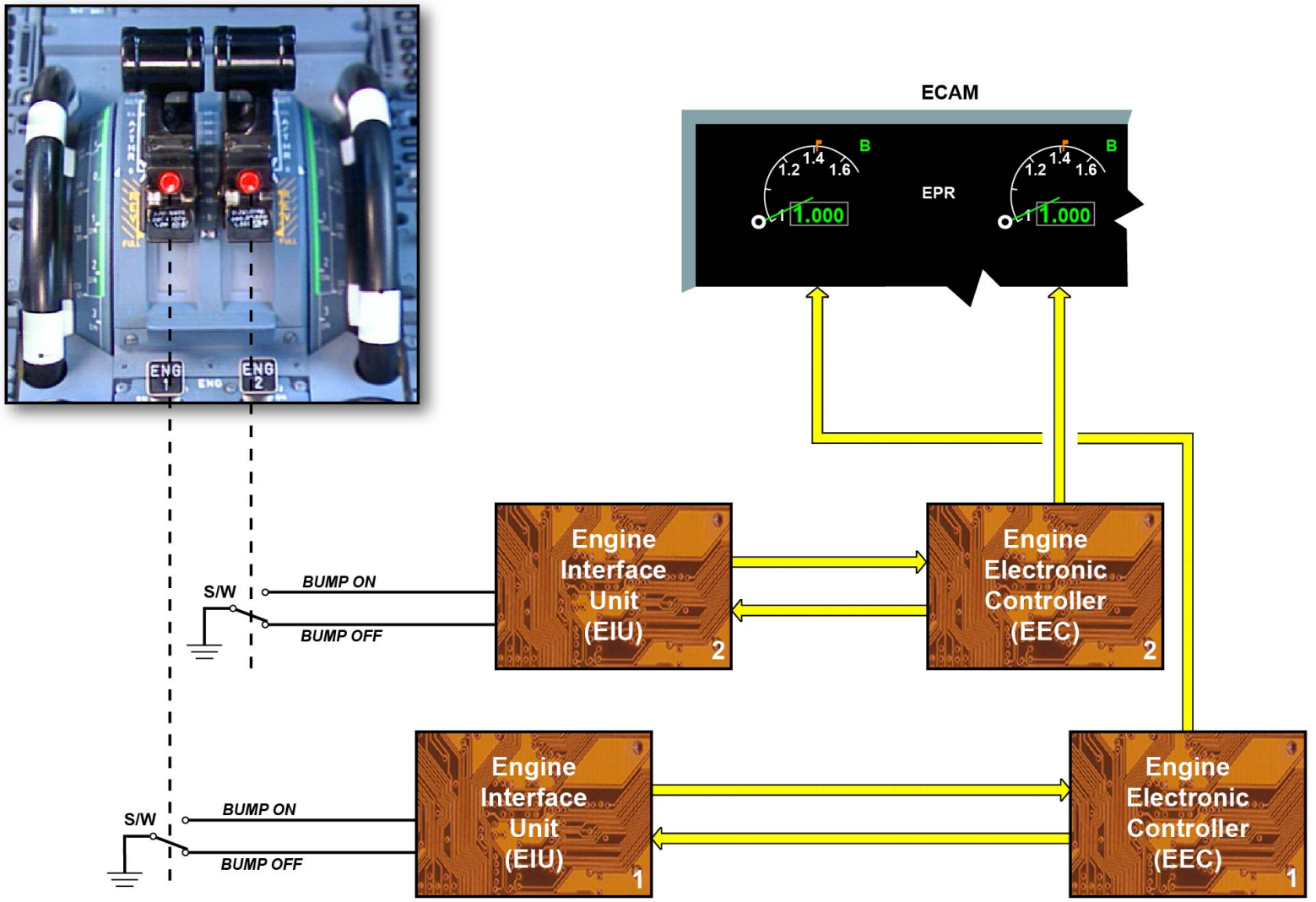


THROTTLE CONTROL UNIT

THROTTLE CONTROL SYSTEM D/O (3)

BUMP FUNCTION (IAE ENGINES ONLY)

If an airline requests the bump function, this function is selected in the aircraft by a pushbutton switch (one on each throttle control lever). With this switch, a signal can be sent to the two FADEC units at the same time through the Engine Interface Unit (EIU).



BUMP FUNCTION (IAE ENGINES ONLY)

ENGINE MONITORING D/O (3)

GENERAL

This system provides the vibration monitoring for both engines.

DUAL ACCELEROMETER

A dual accelerometer is installed on each engine. It provides the analog signals of N1 and N2 vibration frequencies. Only one sensor, A or B, of the dual accelerometer is used at a time and during one flight. It is automatically selected by the Engine Vibration Monitoring Unit (EVMU) at each flight, the second one is in back-up mode in case of failure. These accelerometers are also used for fan trim balance.

NOTE: In case of sensor failure, the transfer to the second sensor is carried out on the ground through the MCDU.

EVMU

An EVMU monitors the N1 and N2 vibration levels of both engines. The EVMU determines for each engine, the N1 and N2 vibration levels by analyzing:
- N1 and N2 speeds,
- dual accelerometer frequency signals.

The EVMU also computes the position and amplitude of the unbalance and is capable of on-board fan trim balancing.

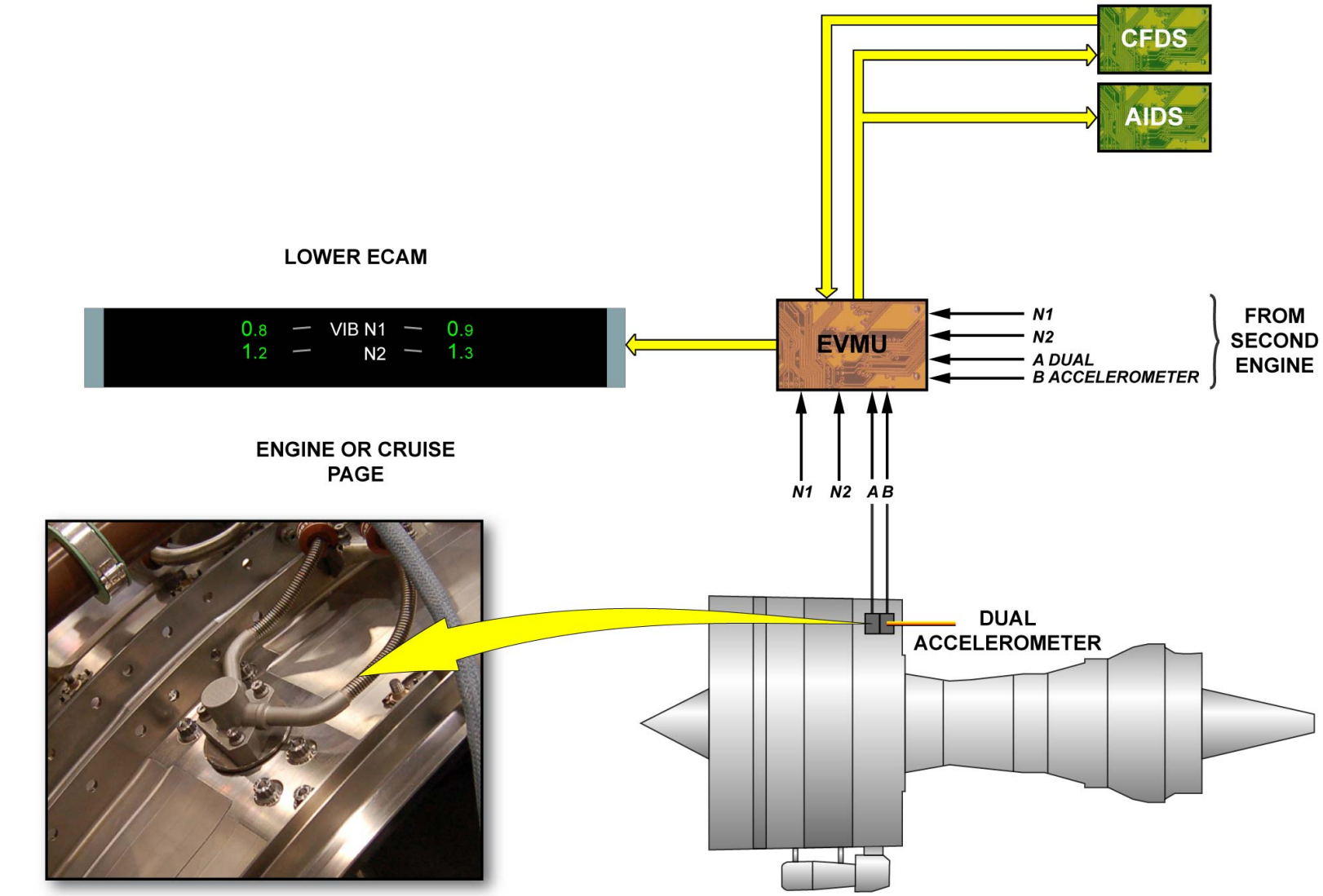
VIBRATION INDICATION

The N1 and N2 vibrations of the left and right engines are displayed on the ENGINE and CRUISE pages. The maximum value that can be displayed is of 10 units. 1 unit for N1 or N2 rotor corresponds to 0.3IPS (Inch Per Second).

INTERFACES

The EVMU interfaces with the ECAM, with the Centralized Fault Display System (CFDS) and the Aircraft Integrated Data System (AIDS). CFDS interface: maintenance fault messages and vibration data analysis. AIDS interface: performance data reports.

NOTE: There is no interface with the Electronic Engine Control (EEC).



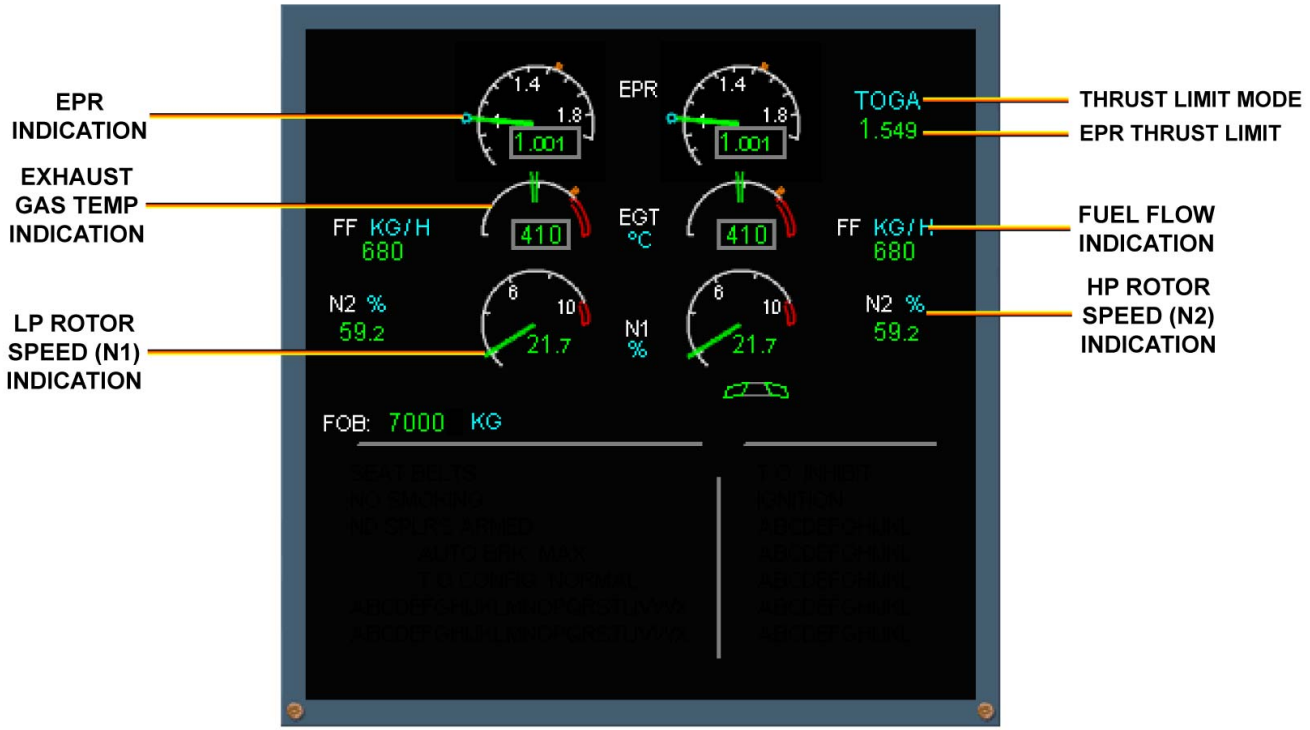
GENERAL - DUAL ACCELEROMETER ... INTERFACES

ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS

The engine primary monitoring parameters displayed on the ECAM EWD are:

- Engine Pressure Ratio (EPR)
- Exhaust Gas Temperature (EGT)
- Low Pressure (LP) rotor speed indication (N1)
- Fuel Flow (FF) indication
- High Pressure (HP) rotor speed indication (N2)
- thrust limit mode
- EPR thrust limit



PRIMARY PARAMETERS

ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

ROTATIONAL SPEED PARAMETERS DESCRIPTION

The fan speed (N1) indicating system has 4 sensors:
o two sensors send N1 rotational speed signal to EEC channel A and B,
o one sensor is a spare for either EEC channel,
o one sensor sends N1 analog signals (trim balance sensor) to the Engine Vibration Monitoring Unit.
The N1 speed sensors and the trim balance sensor are installed on the front brackets attached to the No. 2 bearing support in the front bearing compartment.
The N1 rotational speed indication is shown on the ECAM EWD by a needle and a N1 digital indication display.
The N2 indicating system sends signals proportional to the High Pressure (HP) shaft rotational speed to the EEC for use in engine control computation, to the ECAM for visual display in the cockpit and to the Engine Vibration Monitoring Unit for use in processing engine vibration data. The N2 speed signal is sensed by the dedicated alternator, installed at the front face of the accessory gearbox.

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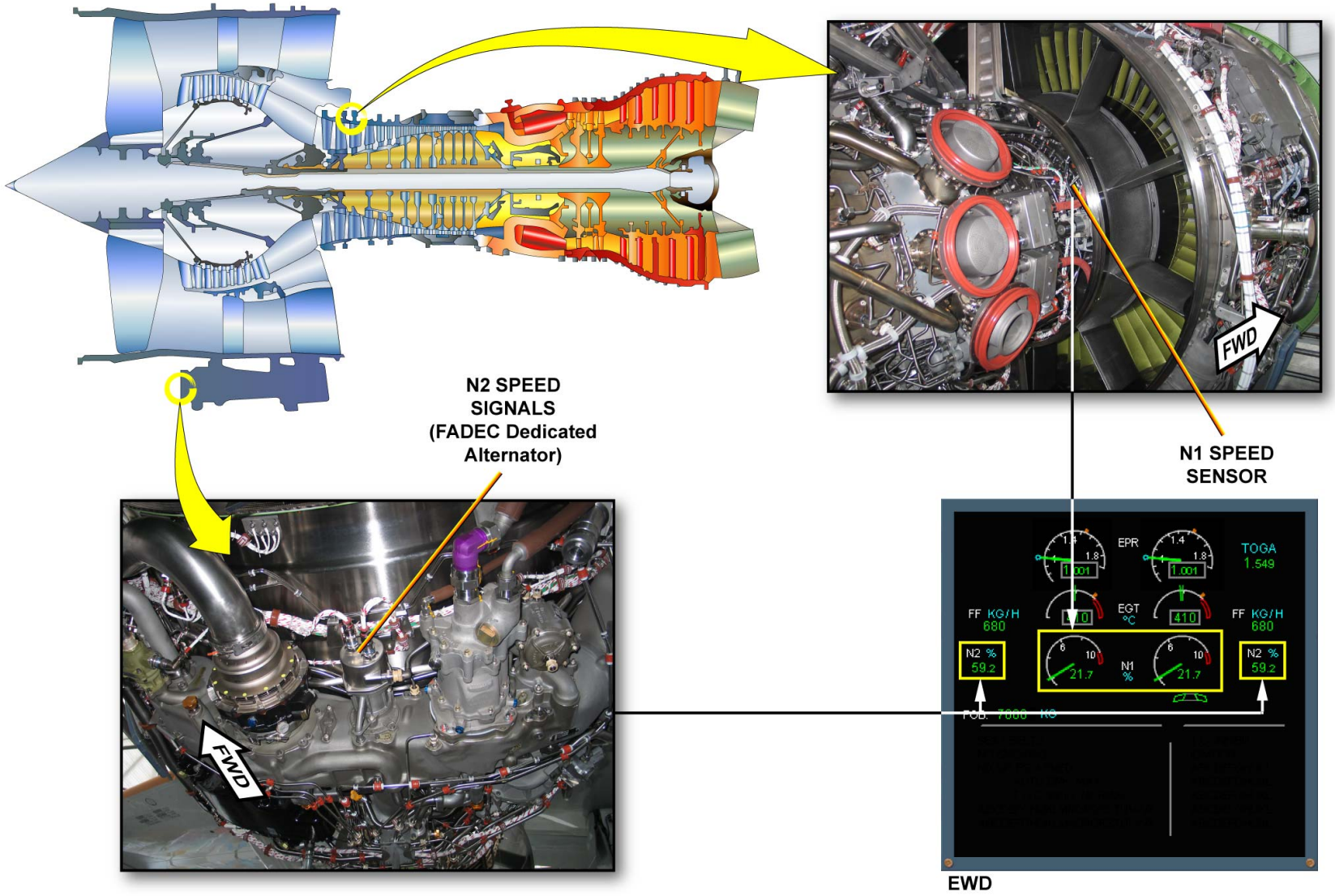


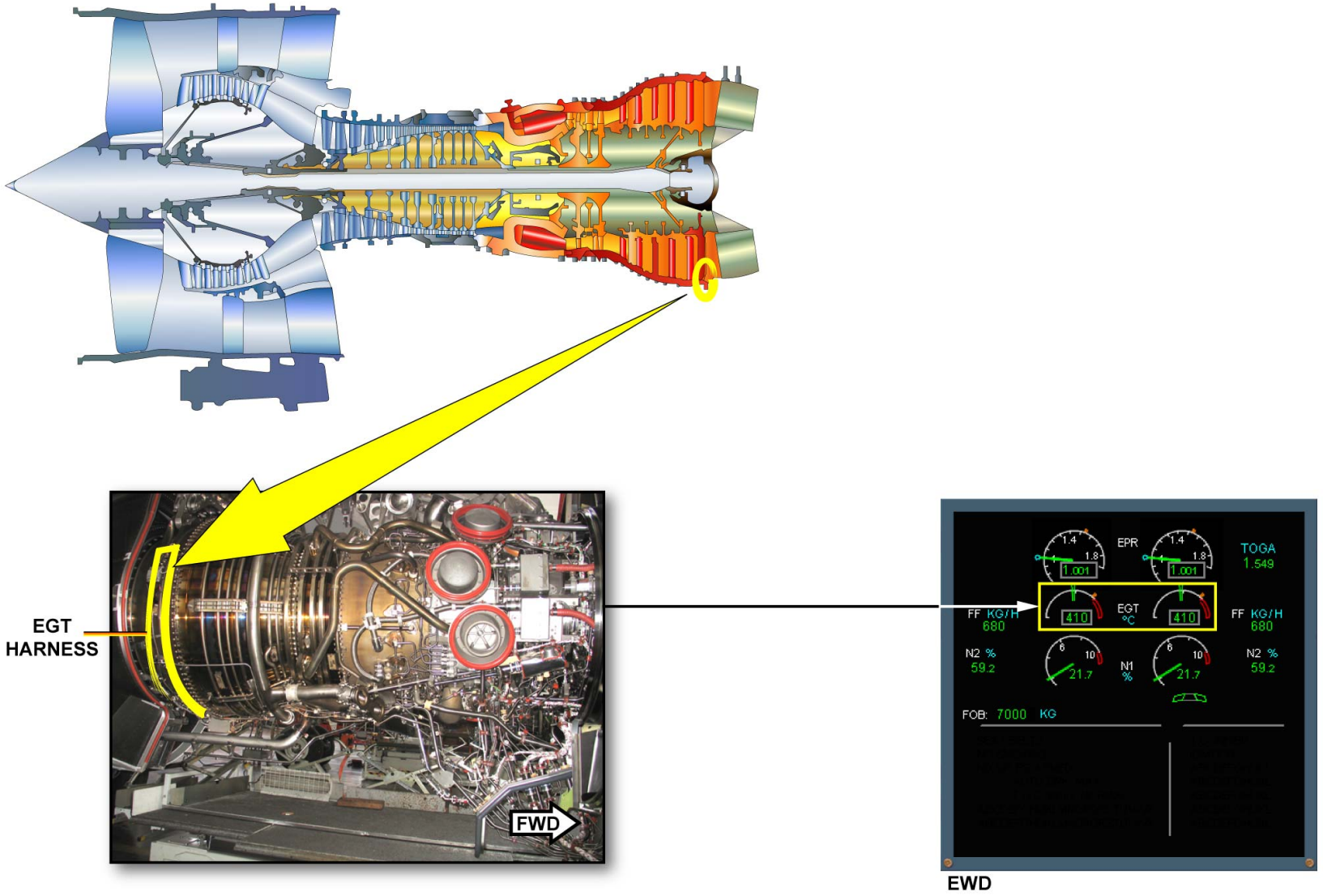
PRIMARY PARAMETERS - ROTATIONAL SPEED PARAMETERS DESCRIPTION

ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

LPT SECTION PARAMETERS DESCRIPTION

The engine EGT is sensed and averaged by 4 thermocouple probe assemblies are located at station 4.95 (LP turbine exhaust case strut) at 9.5, 7.5, 4.5 and 2 o'clock viewed from the rear. The actual engine EGT is displayed on the ECAM EWD with a needle and an EGT digital indication.



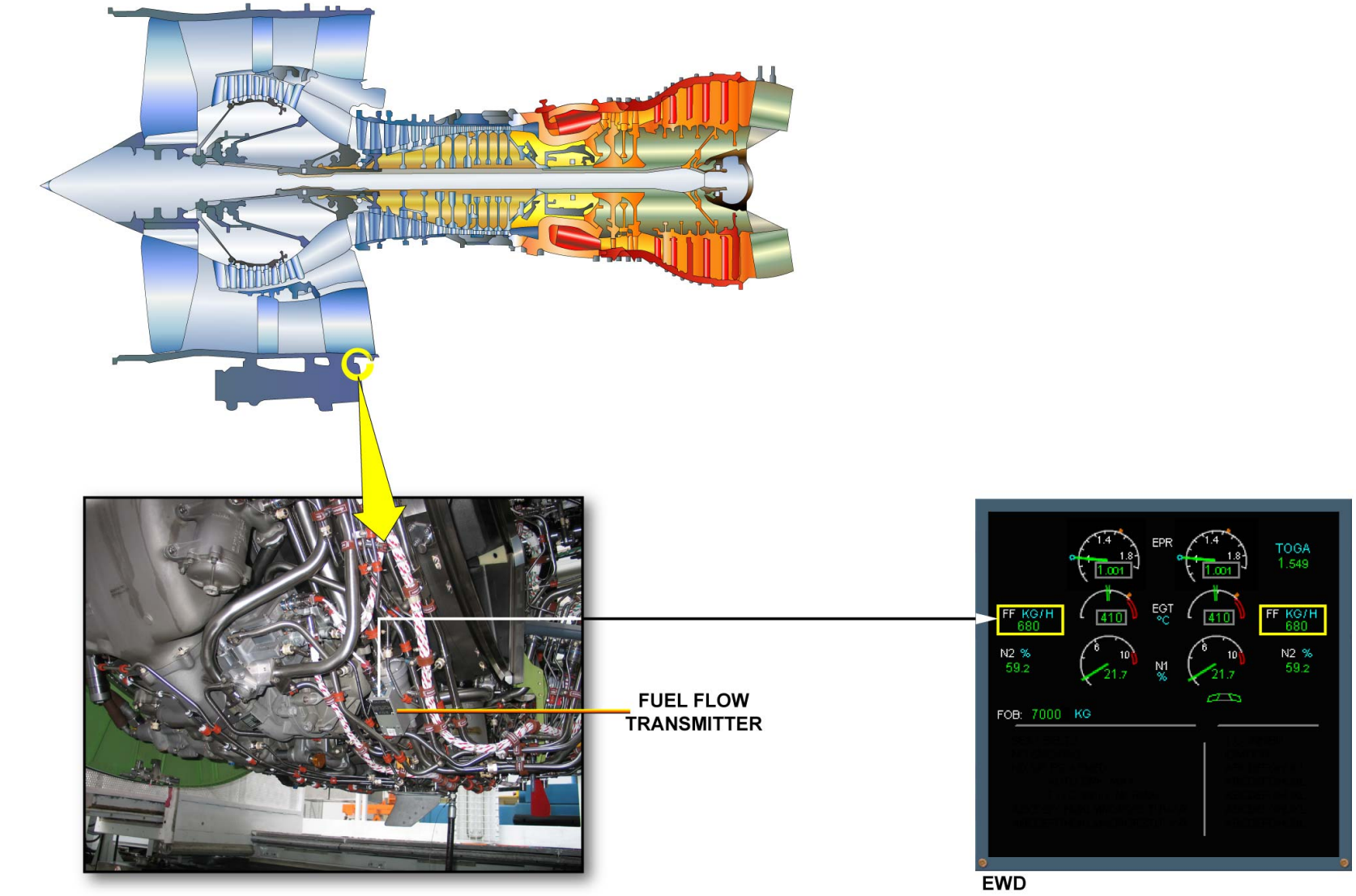
PRIMARY PARAMETERS - LPT SECTION PARAMETERS DESCRIPTION

ENGINE MONITORING D/O (3)

PRIMARY PARAMETERS (continued)

FUEL FLOW PARAMETER DESCRIPTION

The fuel flow transmitter is installed in the fuel line between the fuel metering unit and the fuel distribution valve. It is mounted on the lower left-hand side of the fan case, rearward of the LP/HP fuel pump. The FF is shown on the ECAM EWD by a FF digital indication.



PRIMARY PARAMETERS - FUEL FLOW PARAMETER DESCRIPTION

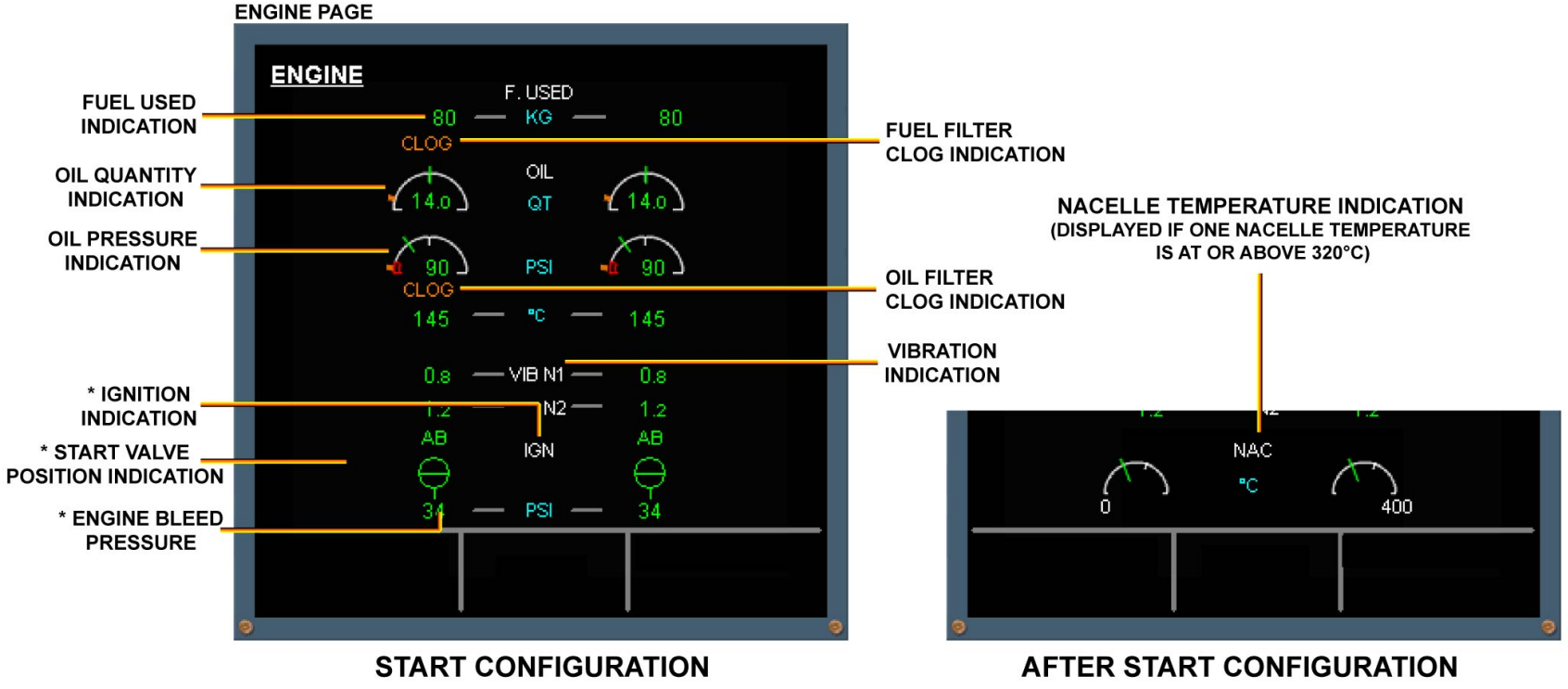
ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS

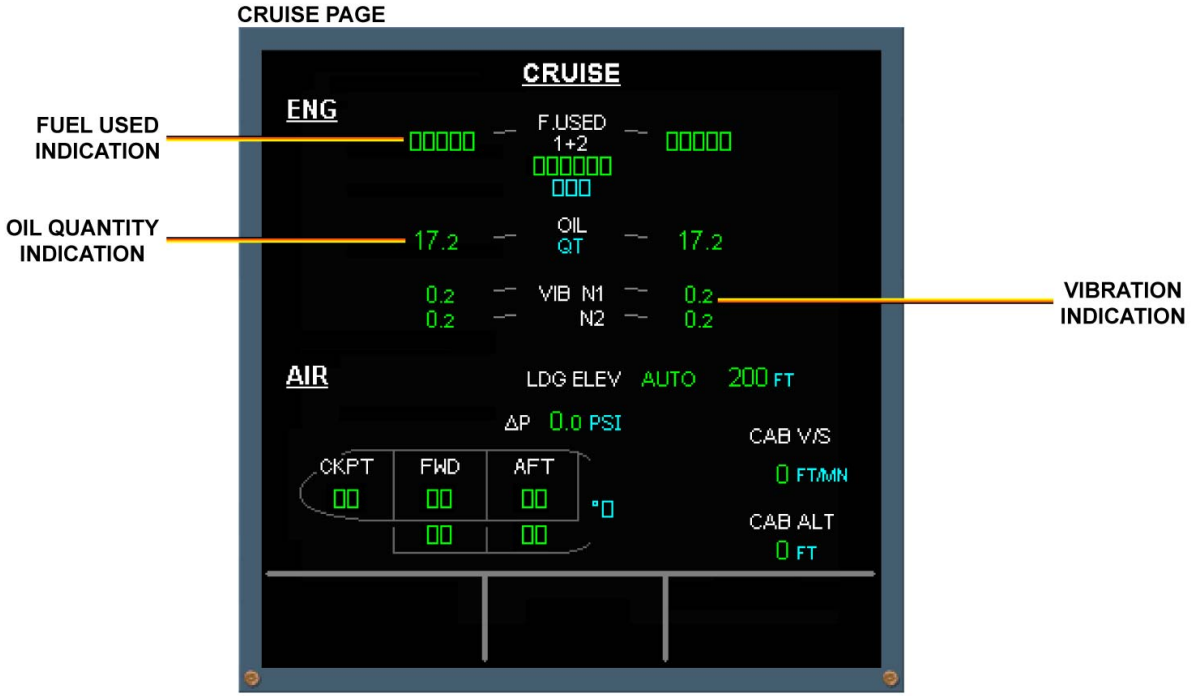
The engine secondary monitoring parameters are displayed on the ECAM lower SD when it is selected manually or automatically.
The engine secondary parameters that appear permanently on the ECAM ENGINE page are:
- fuel used indication,
- oil quantity indication,
- oil pressure indication,
- oil temperature indication,
- vibration indication

The engine secondary parameters not permanently displayed on the SD are:
- oil filter clog indication,
- fuel filter clog indication,
- nacelle temperature indication,
- ignition indication,
- start valve position indication,
- engine bleed pressure.

Fuel used, oil quantity and vibration indications are also displayed on the ECAM CRUISE page.



SECONDARY PARAMETERS



SECONDARY PARAMETERS

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ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

OIL PARAMETERS DESCRIPTION

The oil quantity XMTR is located in the oil tank. It is displayed on the ECAM SD

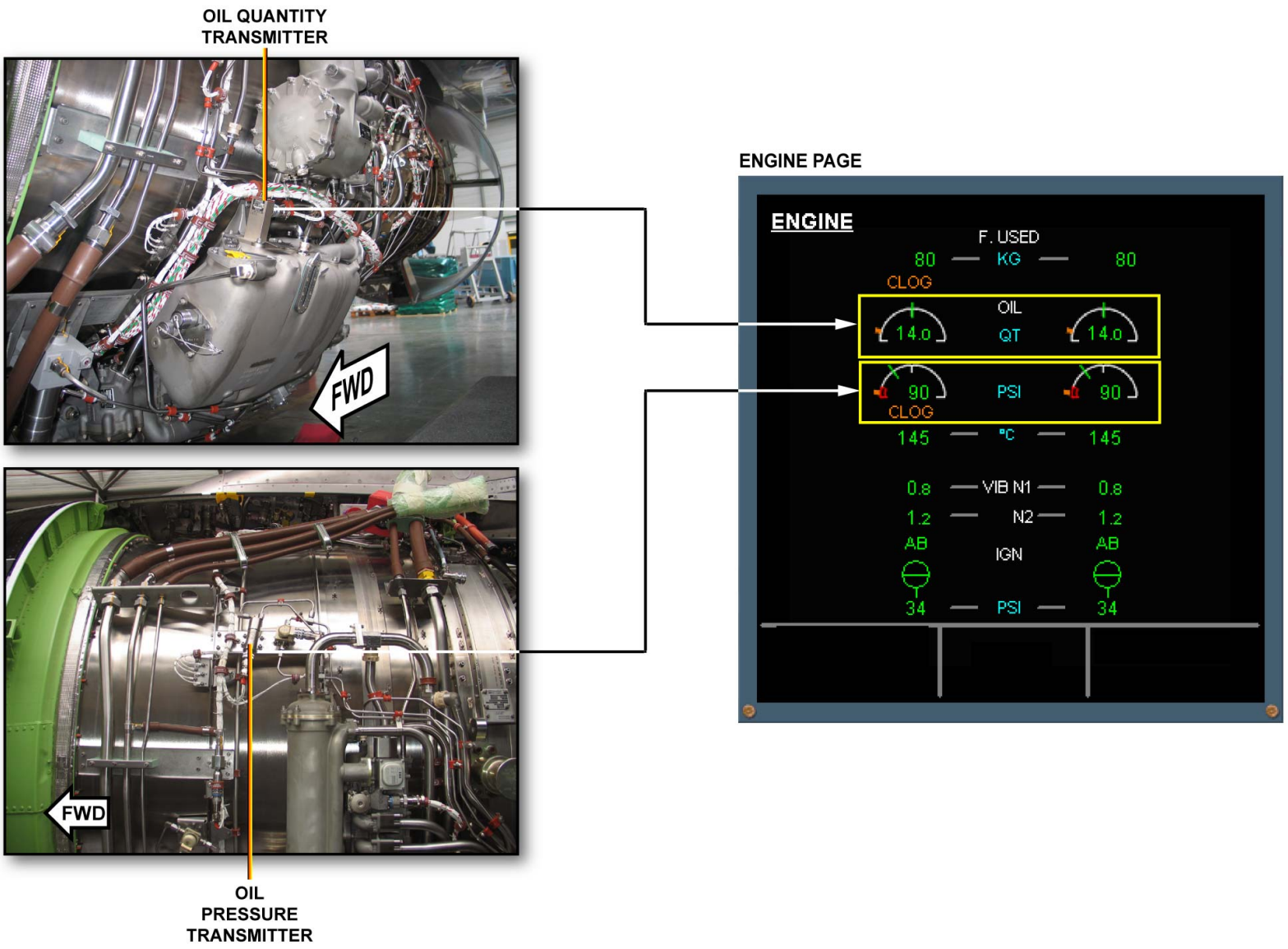
The oil pressure XMTR is bolted to a bracket on the top left side of the engine fan case. It is displayed on ECAM the SD.

The scavenge oil temperature thermocouple is located in the combined scavenge line between the master magnetic chip detector and the scavenge filter for indication in the cockpit.

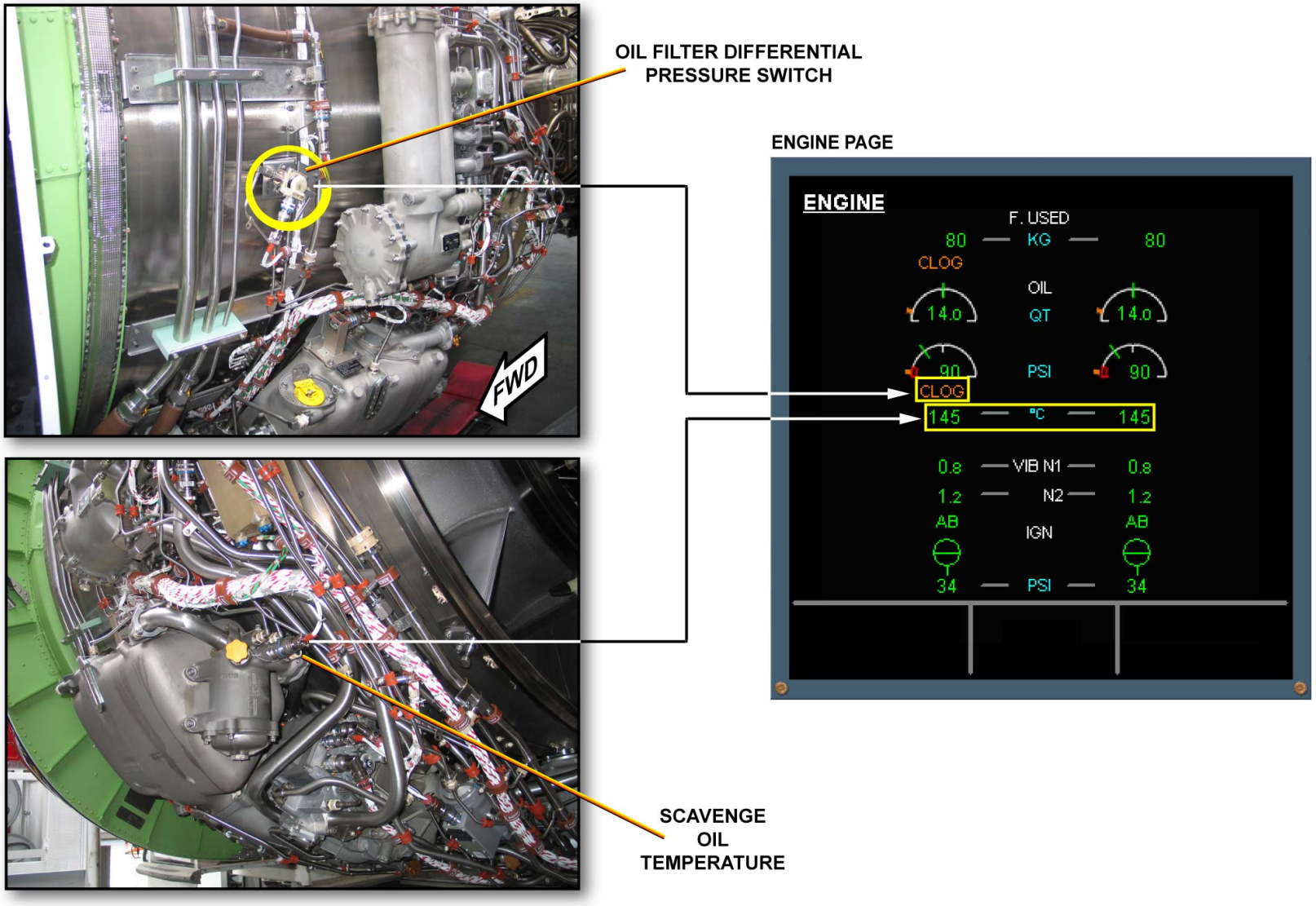
The oil temperature is sensed by a dual resistor unit. The unit has a sealed, wire-wound resistance element. This element causes a linear change in the DC resistance when exposed to a temperature change.
Temperature measurement range: -60°C to 250°C.

The scavenge filter differential pressure switch is installed on a bracket at the top left side of the engine fan case. The switch is connected to ports on the filter housing.

The differential pressure switch is set to operate when the differential pressure increases and gets to 12 psi plus or minus 2 psi



SECONDARY PARAMETERS - OIL PARAMETERS DESCRIPTION



SECONDARY PARAMETERS - OIL PARAMETERS DESCRIPTION

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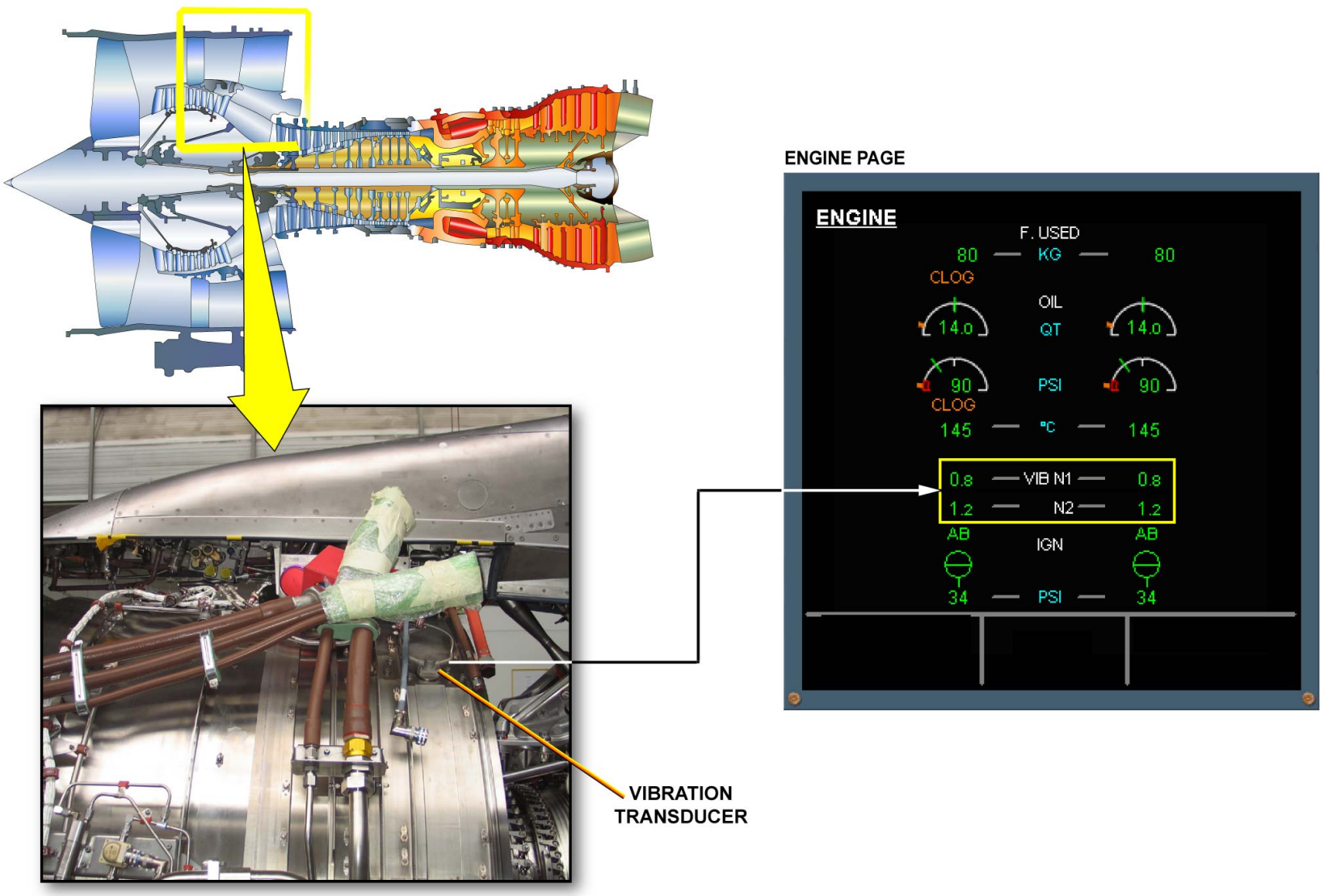
ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

VIBRATION PARAMETERS DESCRIPTION

The system monitors engine vibration for engine 1 and engine 2. On each engine fan case, a vibration transducer does monitoring. This produces an electrical signal in proportion to the vibration detected and sends it to the cockpit. Two channels come from each engine. Each vibration transducer is installed in the fan case at the top left side of the engine. It is attached with bolts and is installed on a mounting plate.



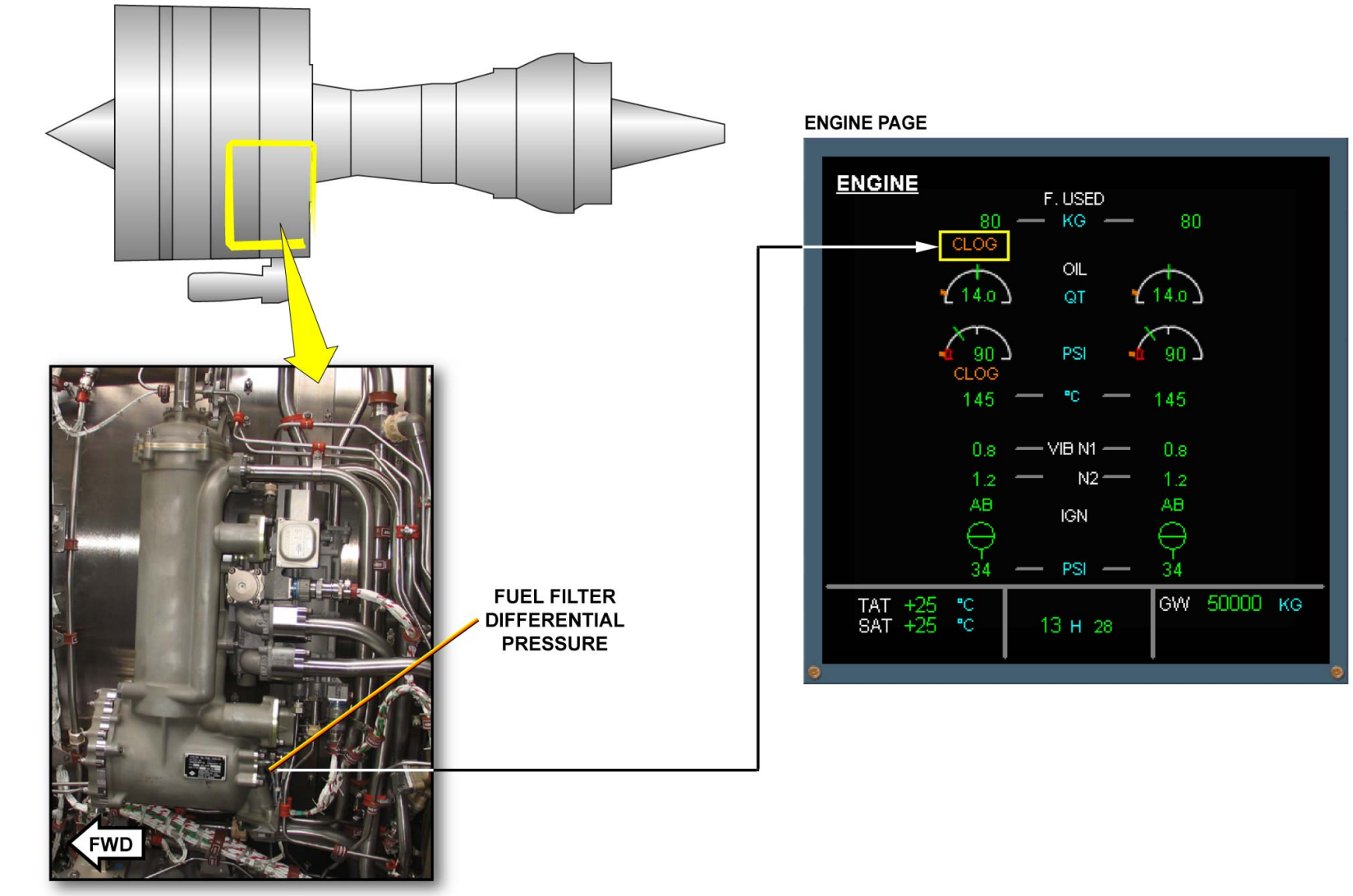
SECONDARY PARAMETERS - VIBRATION PARAMETERS DESCRIPTION

ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

FUEL PARAMETERS DESCRIPTION

The fuel used value computed by the Full Authority Digital Engine Control (FADEC) is displayed in green on the ECAM SD.
A CLOG message appears in amber with an ECAM message only when the differential pressure across the fuel filter is too high.



SECONDARY PARAMETERS - FUEL PARAMETERS DESCRIPTION

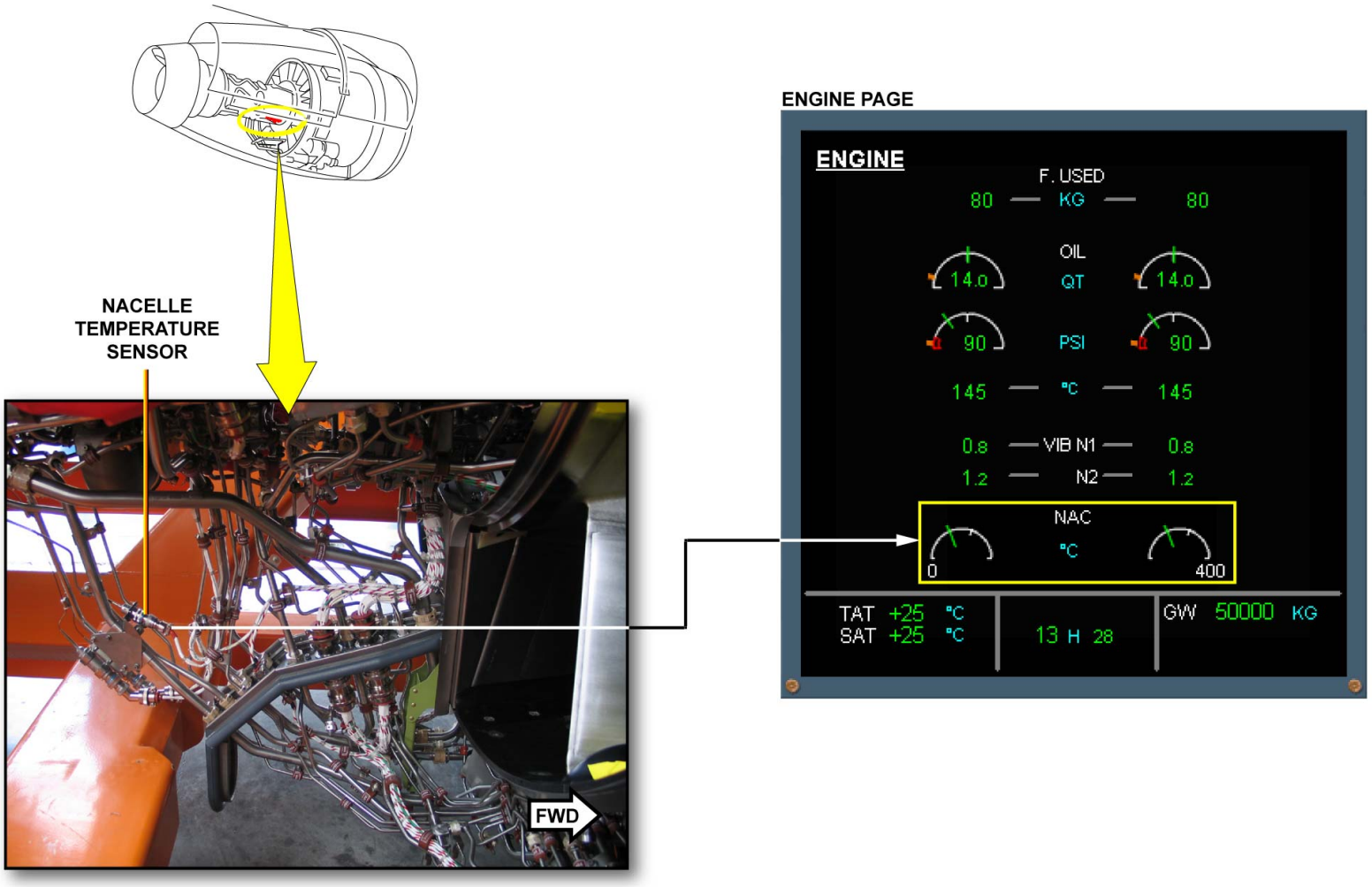
ENGINE MONITORING D/O (3)

SECONDARY PARAMETERS (continued)

NACELLE TEMPERATURE INDICATION

A temperature probe installed in the nacelle core zone ventilation air exit monitors the nacelle temperature.
The nacelle temperature sensor can give the indication to the ECAM SD.

UGB13131 - U64T2M0 - UM77D2IAE000002



SECONDARY PARAMETERS - NACELLE TEMPERATURE INDICATION

ENGINE MONITORING D/O (3)

OPTIONAL PARAMETERS

These additional engine sensors are optional and dedicated to the engine condition monitoring through the AIDS. These engine parameters (P12.5, P2.5, T2.5) are available on the EEC data bus output if installed on the engine:

- P12.5 sensor supplies air pressure from the fan exit,
- P2.5 sensor supplies air pressure from the LP compressor exit,
- T2.5 sensor supplies air pressure from the LP compressor exit.

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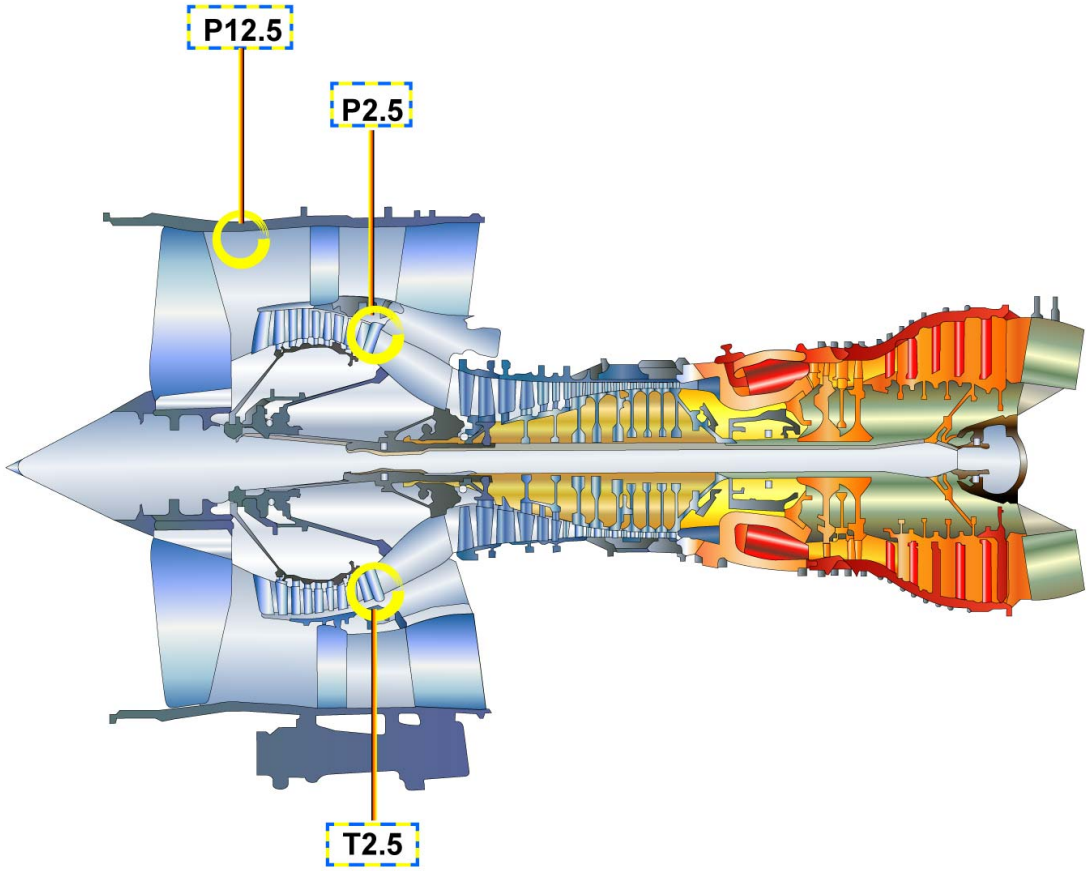


OPTION

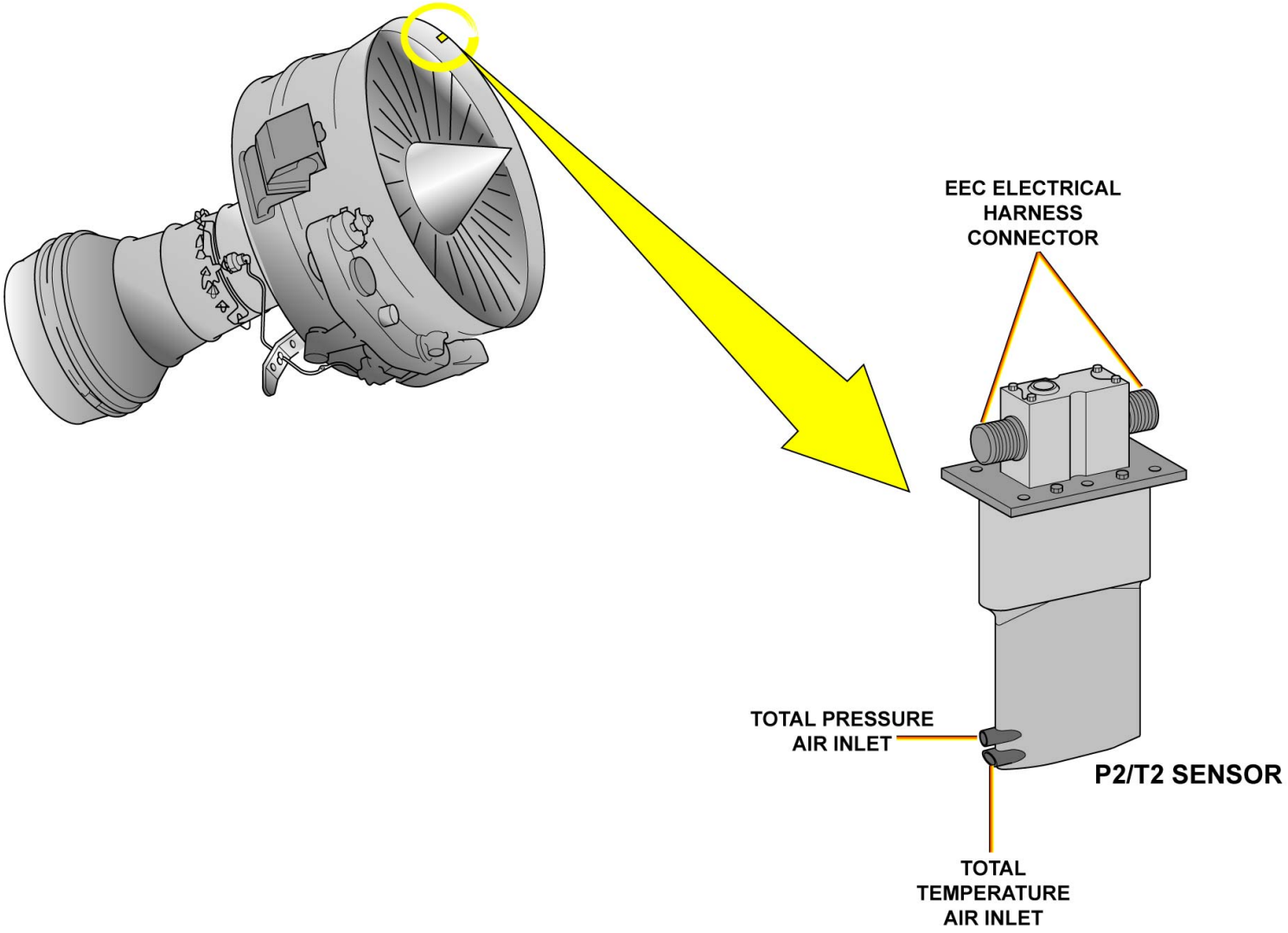
OPTIONAL PARAMETERS

ENGINE MONITORING D/O (3)

INLET AIR STREAM PARAMETERS DESCRIPTION

The P2/T2 sensor is located near the 12 o'clock position of the inlet cowl. It measures total pressure and temperature in the inlet air stream of the engine forward of the engine front flange.

UGB13131 - U64T2M0 - UM77D2IAE000002



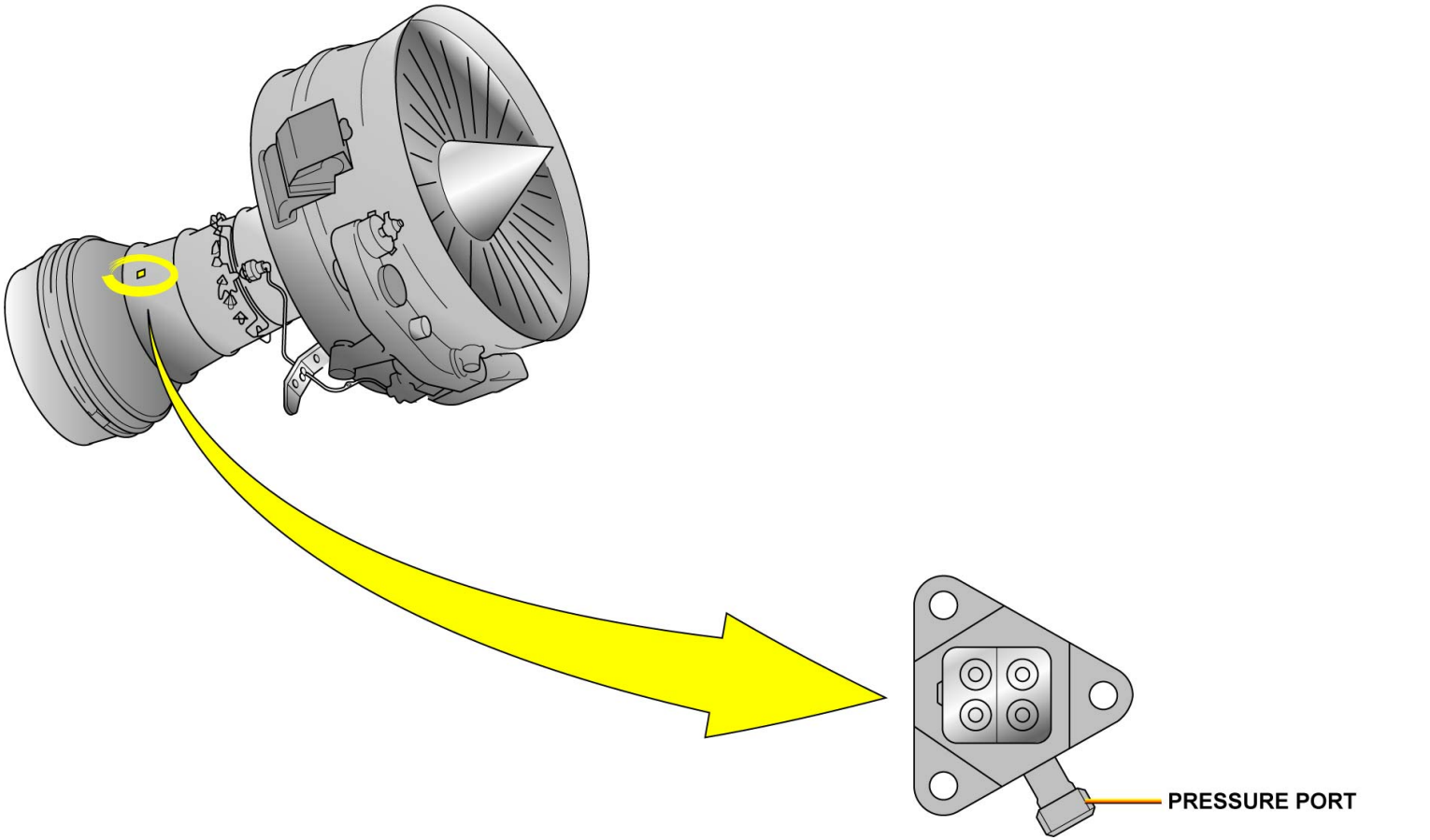
INLET AIR STREAM PARAMETERS DESCRIPTION

ENGINE MONITORING D/O (3)

HP COMPRESSOR EXIT PARAMETERS DESCRITPION

The P3/T3 sensor monitors the pressure and temperature at the exit of the HP compressor. The combined sensor houses two thermocouples and one pressure inlet port. Each thermocouple sends an independent electrical signal, proportional to the temperature, to one channel of the Electronic Engine Control (EEC).
The function of the P3/T3 sensor is to give performance data to the EEC for starting and during transient and steady state operation of the engine.

UGB13131 - U64T2M0 - UM77D2IAE000002



PRESSURE AND TEMPERATURE SENSOR (P3/T3)

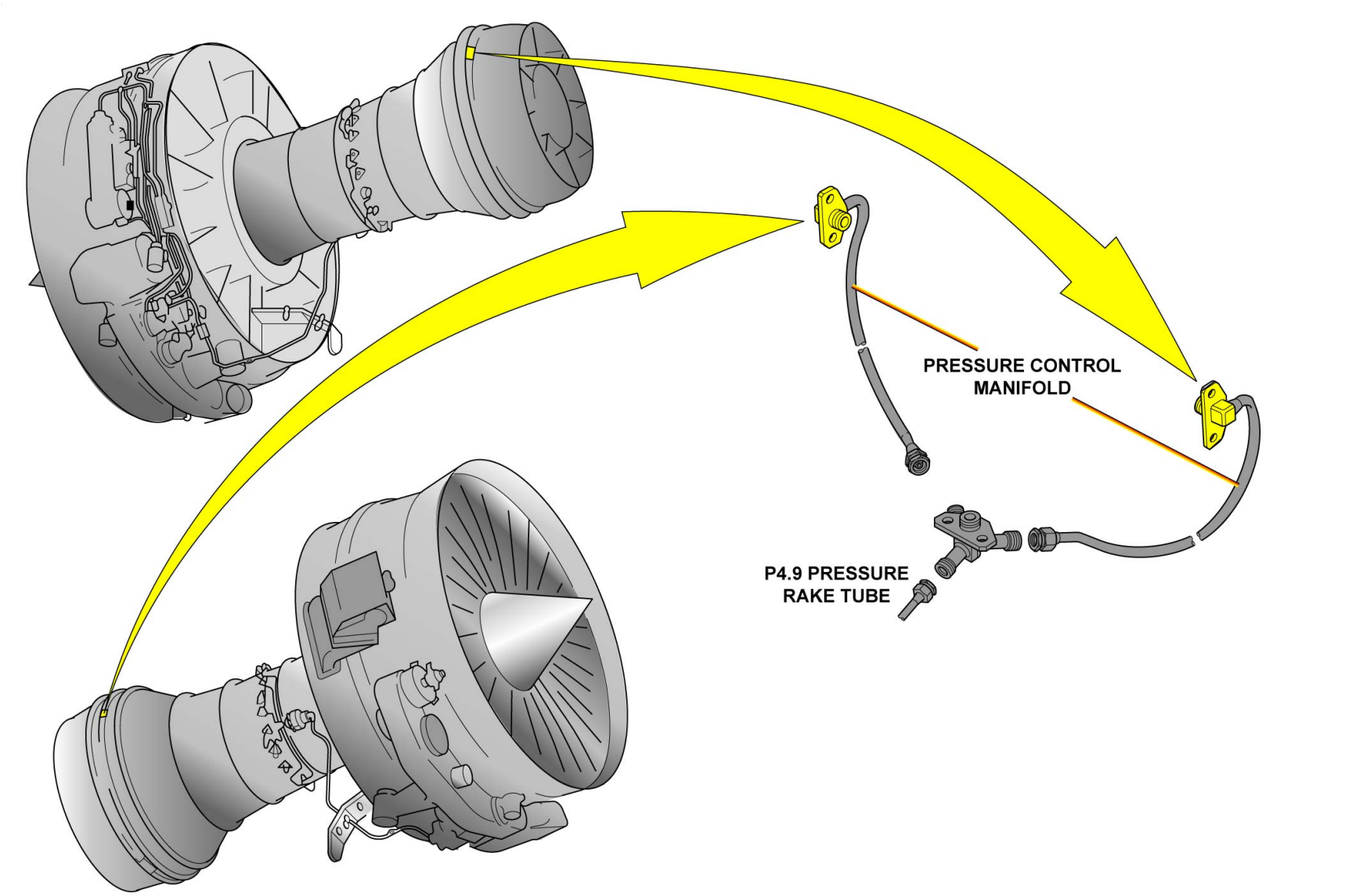
HP COMPRESSOR EXIT PARAMETERS DESCRITPION

ENGINE MONITORING D/O (3)

TURBINE EXHAUST CASE PARAMETERS DESCRITPION

Pressure sensing instrumentation is included in the leading edge of specific turbine exhaust case struts. Struts 4, 7 and 10 contain the pressure sensing ports. The pressure value is then ducted into a manifold, which supplies an overall turbine exhaust pressure average (P4.9). A tube from this manifold is connected to the Electronic Engine Control (EEC).
A pressure transducer installed within the EEC converts the average pressure at station 4.9 into a useable electronic signal (proportional to the pressure) that can be processed and used by the EEC as required to control the engine, perform fault detection.

UGB13131 - U64T2M0 - UM77D2IAE000002



TURBINE EXHAUST CASE PARAMETERS DESCRITPION

ENGINE SYSTEM OPERATION, CONTROL & INDICATING (IAE V2500) (3)

FADEC POWERING / ENGINE CONTROLS

N1 MODE RATED

ENG 1 + 2 EPR MODE FAULT - N1 UNRATED

ENG 1 HP FUEL VALVE FAULT

ENG 1 EIU FAULT

ENG 1 OIL FILTER CLOG

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