TWIN-ENGINE AIRCRAFT
HYDRAULIC SYSTEM
mod. AQ-2/EV

THEORY AND EXERCISES

TEACHER/STUDENT handbook

ElettronicaVeneta

C O N T E N T S

SAFETY STANDARDS

PLEASE READ THE FOLLOWING DIRECTIONS CAREFULLY BECAUSE THEY GIVE IMPORTANT INFORMATION ABOUT THE SAFETY OF INSTALLATION, USE AND MAINTENANCE.

Keep this handbook with care so that is can be consulted in any time.

INSTALLATION

After unpacking the equipment, make sure of the integrity of its components.
In detail, make sure that the equipment and its accessories are sound, without visible damages provoked by the transport.
Before connecting the equipment with the mains, check that its rating corresponds to that of the mains.
Arrange the power cables so that they cannot be trodden, nor squeezed by some object. If the mains socket and the plug of the equipment do not match, the socket or the plug must be replaced with a compatible one by a skilled electrician. This technician must also check that the wires have the right section for bearing the power absorbed by the equipment. It is better not to use any adapter nor multiple outlet.
However, if any simple or multiple adapter or extension will be used, they must comply with the safety rules in force; but take care not to exceed the limit value of current carrying capacity, marked on simple adapters and on extensions, nor the value of maximum power marked on multiple adapters.
Any installation must comply with the manufacturer's instructions and it must be carried out with recommended accessories.

ADVICE OF USE

Use this equipment exclusively for the aims which it has been expressly conceived for, that is for educational purposes; furthermore its operation must take place under the direct supervision of a skilled staff.
Any different use is not proper, therefore it is dangerous. The manufacturer is not responsible for any damage due to improper, erroneous and irrational uses.

PRECAUTIONS

Take care not to open this equipment, not to tamper with nor remove protection covers (high voltages, high temperatures, case-protected moving parts...), so that the operator's safety and the correct operation of the apparatus are ensured.

Before replacing fuses disconnect the equipment from the mains.

When some objects or liquids penetrate into the equipment, disconnect the power cord and before switching the equipment on again make it be checked by a skilled technician.

In case of trouble and/or malfunction, switch the equipment off immediately and do not tamper it. For possible repairs refer to the nearest after-sales centre or require original spare parts exclusively. Not complying with these instructions could compromise the equipment's safety.

Take care not to provoke any vibration, nor shocks.

CLEANING THE EQUIPMENT

Clean the case of the equipment and the panel of schematic diagram, with a dry and soft cloth. Never use insecticides nor chemical products nor solvents, for cleaning.

These apparatuses and all their parts will be disposed of separately from the other wastes. At the end of their lifetime, these apparatuses will be conveyed to the proper centres of separate collection of waste.

A proper separate collection ensures that the eliminated apparatuses will undergo the necessary treatment and recycling for preventing any negative effect on the environment and on men's health.

Illegal disposal of the product by the user involves the application of administrative sanctions referred to Italy, in D.Lgs. no. N. 152/2006 art. 255 and 256, as amended; and directive 2008/98/EC of the european parliament and of the council of 19 November 2008

For states outside the European Union comply with local laws.

1. INTRODUCING THE SIMULATOR

1.1 Training program

Knowing the hydraulic system structure of a twin-engine aircraft is essential for basic training on technical solutions currently operating in aeronautical systems.

The simulator AQ-2/EV consists of a panel with color silkscreen synoptic managed by computer.

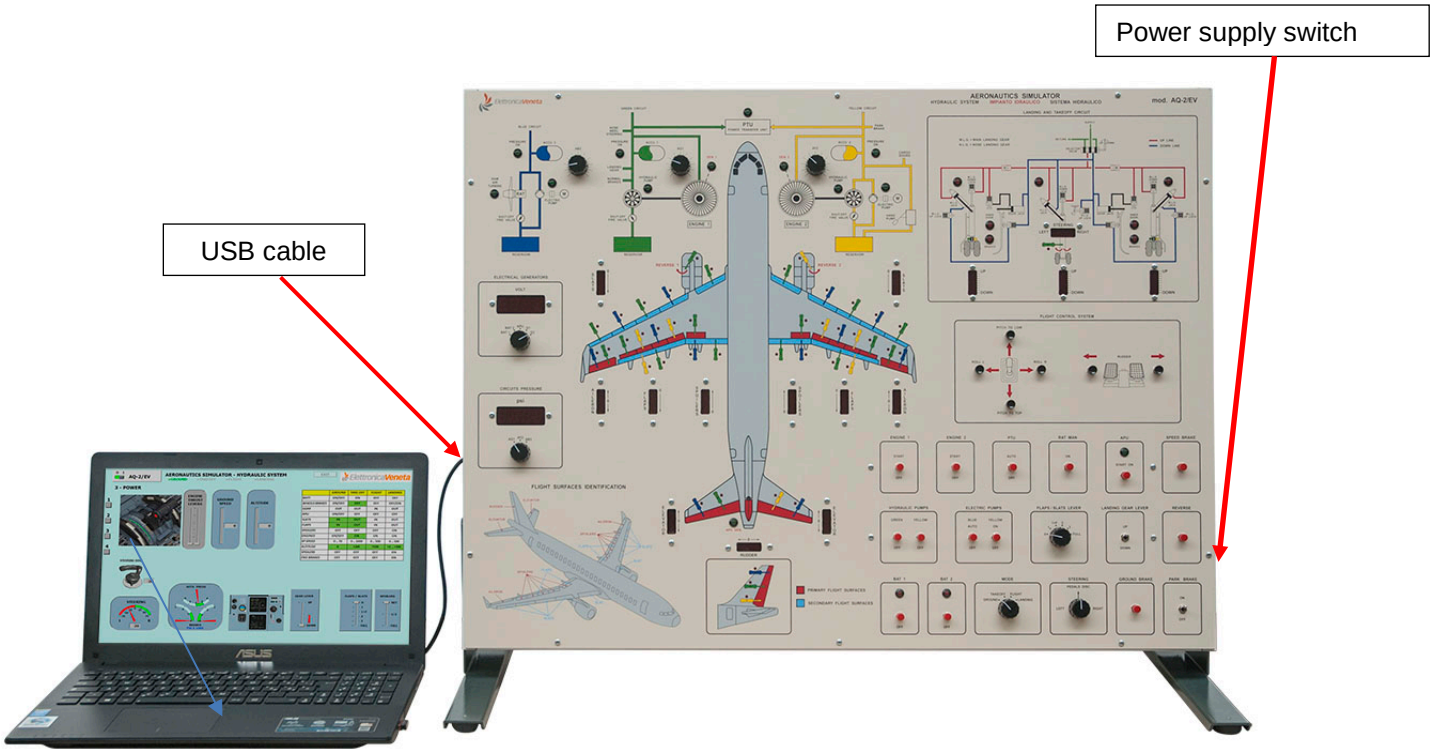
The technical characteristics described correspond to the Airbus A320, world's most popular mono corridor aircraft with the Boeing B727 using similar technologies.

Training program:
- Architecture of the hydraulic system
- Hydraulic power control
- Hydraulic Components
- Hydraulic circuits
- Landing gears
- Thrust reverse
- APU
- RAT

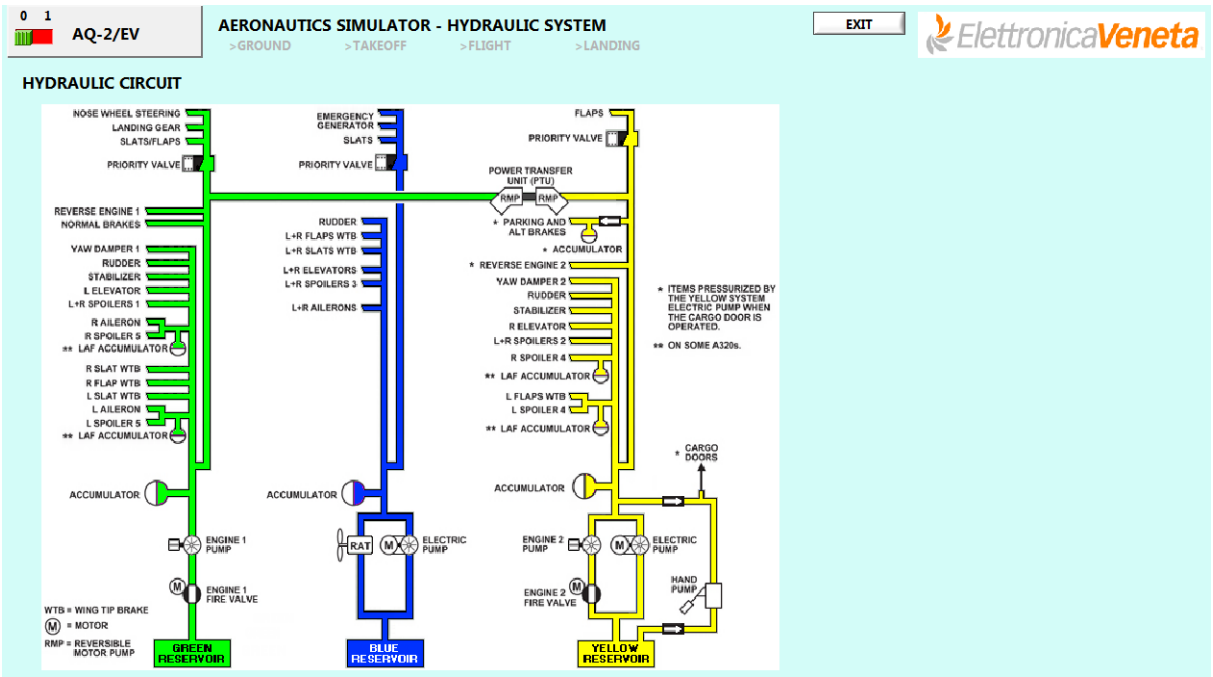
1.2 Trainer description

- The simulator is managed by a computer with the following features:
  - Personal Computer with USB port.
  - mod. AQ-2/EV trainer panel with USB port.
  - Simulator management software (CDROM)
  - Labview software environment

- Connect the power supply according with the voltage indicated on the right side of the panel.



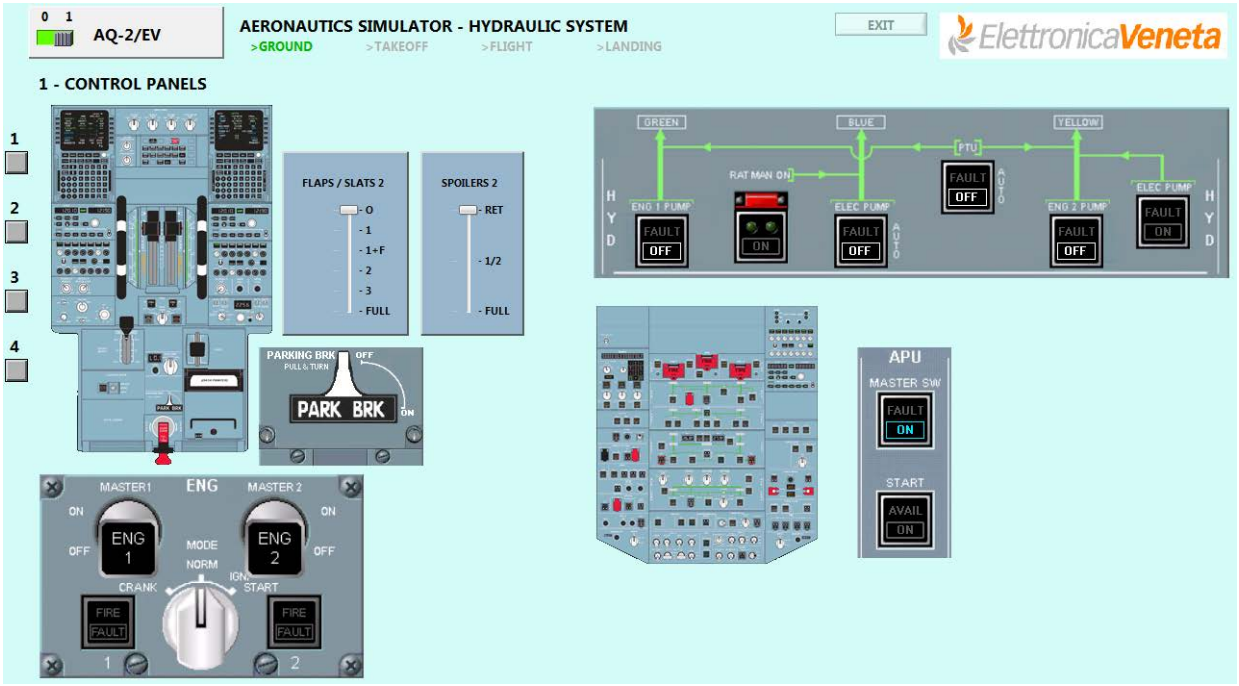
- Boot the control program by clicking on the starting icon
- The following screen will be displayed:



Enable the control of the program by clicking on the button located in the upper left part:

- Red LED = disabled
- Green LED = enabled

- The starting screen is displayed here below:



- When booted, the simulator shows all the flight control surfaces in central position.

- The simulator can be controlled as indicated here below:
- selector “psi” enables to display the pressure set in the three hydraulic circuits of the aircraft:
  -Yellow circuit: potentiometer AY2 (0 – 4000 psi)
  - Green circuit: potentiometer AG1 (0 – 4000 psi)
  - Blue circuit: potentiometer AB3 (0 – 4000 psi)

- Selector “VOLT” enables to display the voltage:
  - of battery BAT 1
  - of battery BAT 2
  - of the Auxiliary Power Unit (APU)
  - of generator G1
  - of generator G2

- All the commands for the control of the simulations are grouped on the right side: these simulations are organized in four MODES:
  - GROUND
  - TAKEOFF
  - FLIGHT
  - LANDING

1.3 Simulator start-up

- Connect the USB cable between the simulator mod. AQ-2/EV and computer.

- The CDROM with software setup is composed by the following folders:

  - \LV_Runtime 82 \ Volume \ Setup.exe [Software Labview)]

  - \Divers \ SetDrv??.exe
    [Select USB driver according with the operational system version]

  - \ AQ2_nn \ Setup.exe [hydraulic system application software]

2. HYDRAULIC SYSTEM

2.1 Hydraulic circuits

- The hydraulic system uses an incompressible fluid enabling to distribute and control the energy. Therefore this system must include a section for the transformation of mechanic energy into hydraulic energy, a circuit for its transport equipped with the suitable control and regulation devices, as well as the power consuming devices which transform the hydraulic energy again into mechanic energy.

- The main advantages offered by the energy transport via an incompressible fluid are:
  - low weight per unit of installed power
  - high transmission efficiency
  - high flexibility of installation
  - ability of bearing overloads without damages
  - high reliability
  - minimum routine servicing
  - low system inertia and consequently rather high frequency response
  - easy checks

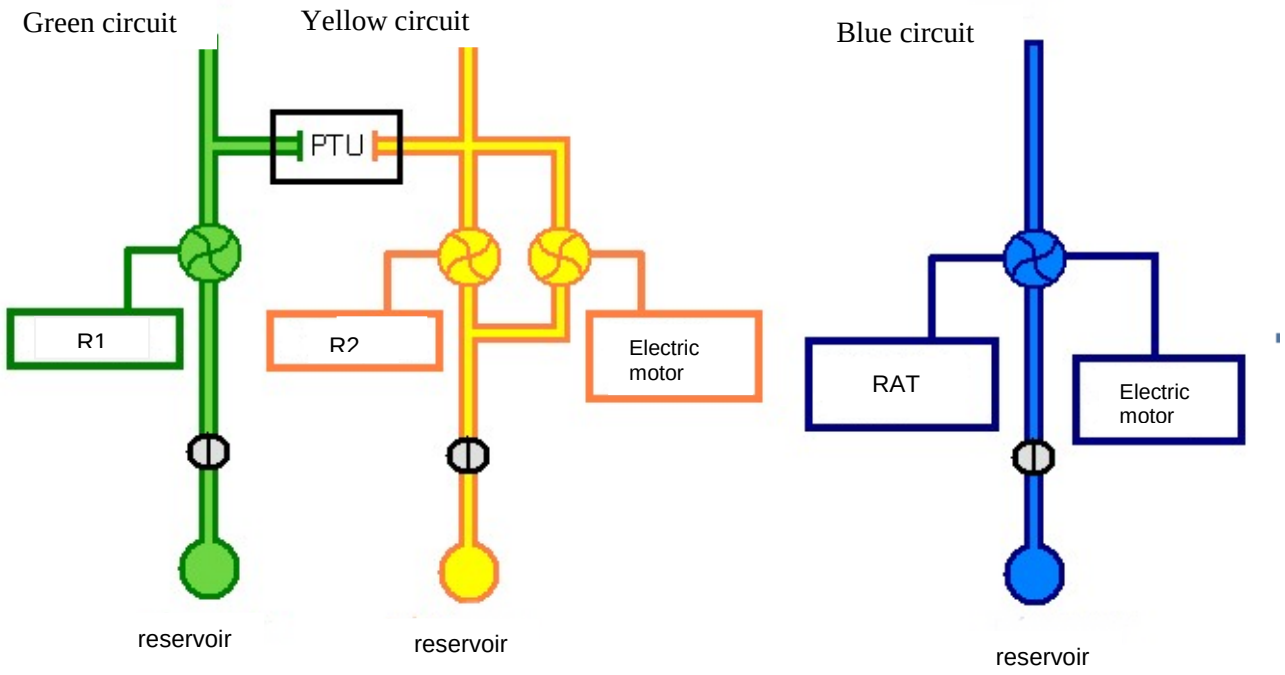
The disadvantages are:
- possible loss of the whole system for the breaking of each component
- hard synchronization of several actuators
- the fluids with the best characteristics of use are not completely fireproof.

2.2 Hydraulic system

- The hydraulic energy is used by the main actuators of an aircraft, such as ailerons, rudders, brakes, thrust reverse, landing gears, etc…

- Like all the other systems, this system too is organized as "source/consuming device": the hydraulic energy flows from the reservoirs up to the actuators. An aircraft is equipped with three circuits being almost identical, but completely separate: in normal conditions all these three circuits must operate simultaneously. That enables to guarantee a high safety level if a fault occurs in one of these circuits.

Organization of hydraulic circuits



Pumps

Valves

- The colours of the three circuits are necessary for a better identification of the various parts of the system. These colours are also used in the checking and control panels.
- The pump of the green circuit is driven by engine 1.
- The yellow circuit will use two pumps: a pump is driven by engine 2 and the other pump by a separate motor. But only one pump is sufficient, the pump driven by engine 2 starts running when the engine is operating.
- The pressure of the hydraulic circuits is equal to 3000 psi (206.8 bars)

- A device called PTU (Power Transfer Unit) is inserted between the yellow and green circuits: this unit enables to pressurize one of these two circuits with the pressure of the other circuit, without any transfer of fluid. This system is useful when a fault (e.g.: a fault of the pump) occurs in one of the two circuits.

- Furthermore this unit starts operating as soon as the pressure difference between the two circuits exceeds 500 psi (approximately 34.4 bars).

- The blue circuit is pressurized by a separate electric motor and by an emergency turbine, if necessary: this turbine uses a small propeller jutting out from the aircraft fuselage, to output energy.

- The Ram Air Turbine (RAT) is an emergency generator which is used in case of any fault in engines: this turbine pressurizes the blue circuit at 2500 psi (172.4 bars)

Example of operation:

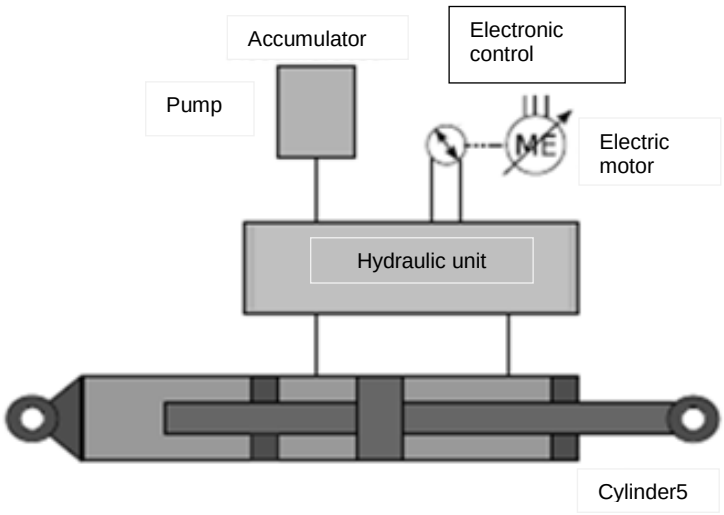
- Engines are off when the aircraft is on the ground, therefore the electric motors of the blue and yellow circuits must be switched on in order to drive the corresponding pumps. The APU and PTU units are enabled so that the green circuit will be pressurized with the pressure of the yellow circuit.

- When the engines are started, the corresponding pumps start running. The electric pump of the yellow circuit is switched off. The pump of the blue circuit is kept on and the PTU can be disabled.

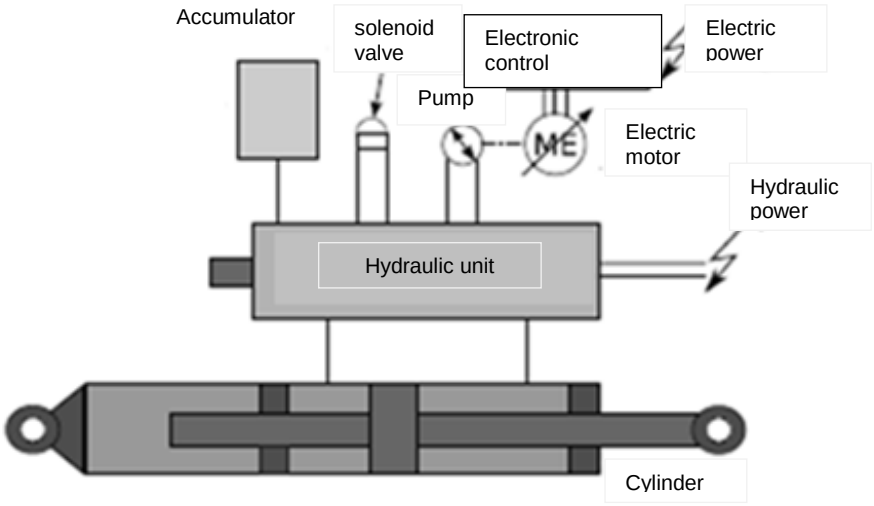
2.3 Hydraulic components

- Aircrafts use three types of actuators for the control of flight surfaces:

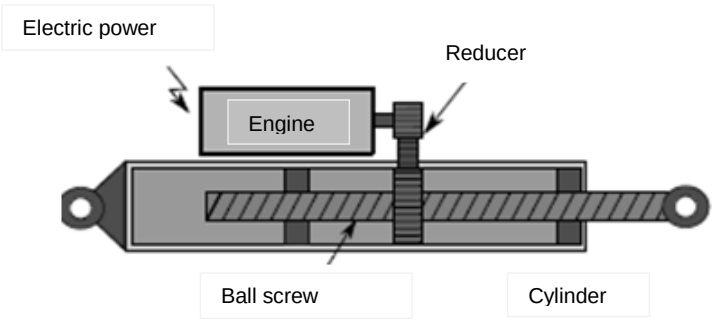
  - EHA (Electro-Hydrostatic Actuator)
    with decentralization of the hydraulic feed system by means of a local reservoir for the fluid



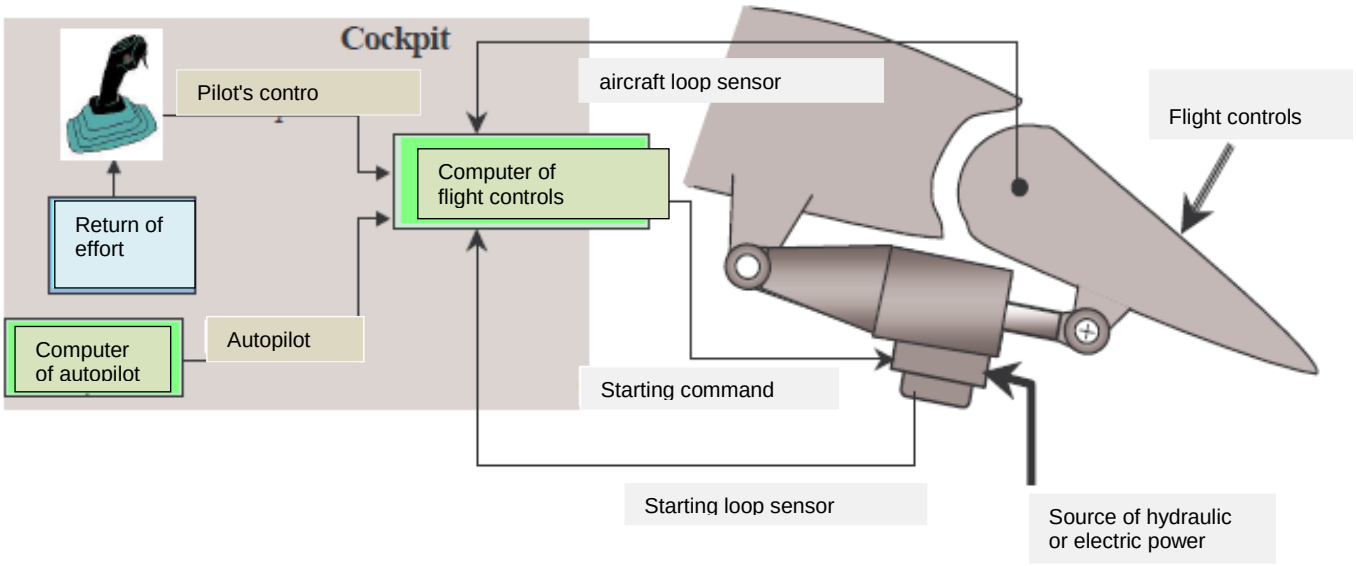
  - EBHA (Electro Back-up Hydraulic Actuator)
    It will increase the reliability when operating as EHA in emergency mode and in normal mode with control solenoid valve and external hydraulic feeding line.



- EMA (Electro Mechanical Actuator)
  Electric control and elimination of the hydraulic circuit.
  It enables the evolution to the “wholly electric” aircraft.

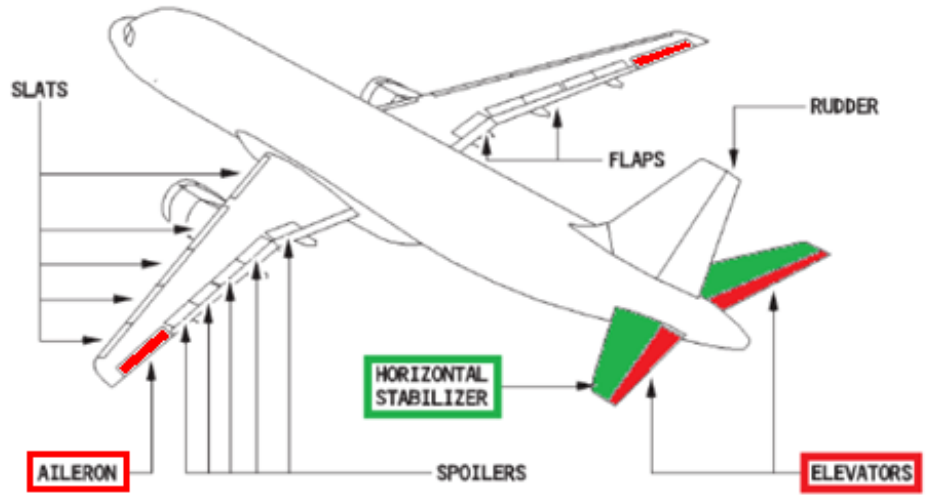


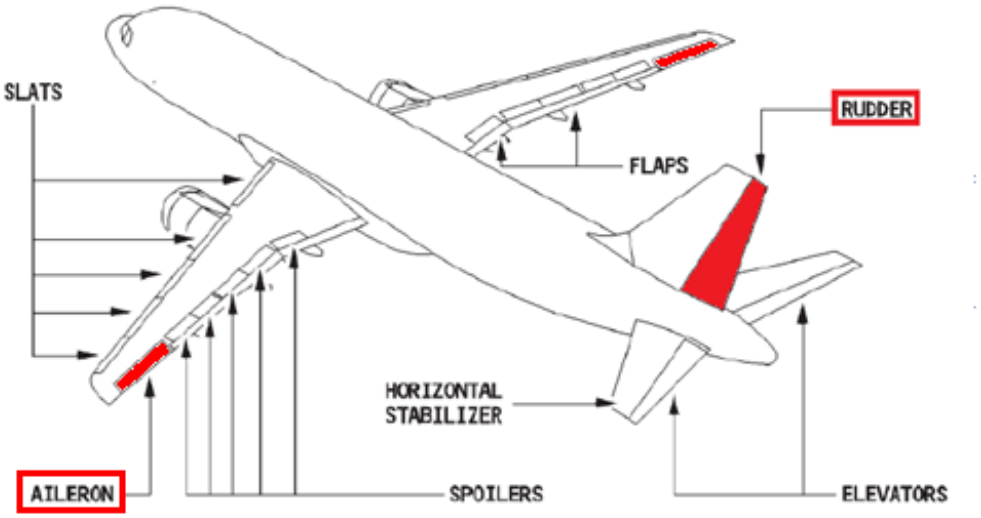
- The automatic control carries out the positioning of the mechanic part according to the checking set point required by the pilot and by the automatisms managing the aircraft
- The flight surface is controlled electronically by a “stick” managed by the pilot: this device sends commands to the various computers which position the flight surface according to the software algorithms, by means of electro-hydraulic cylinders.
- The rudder is operated by the pilot with pedals.



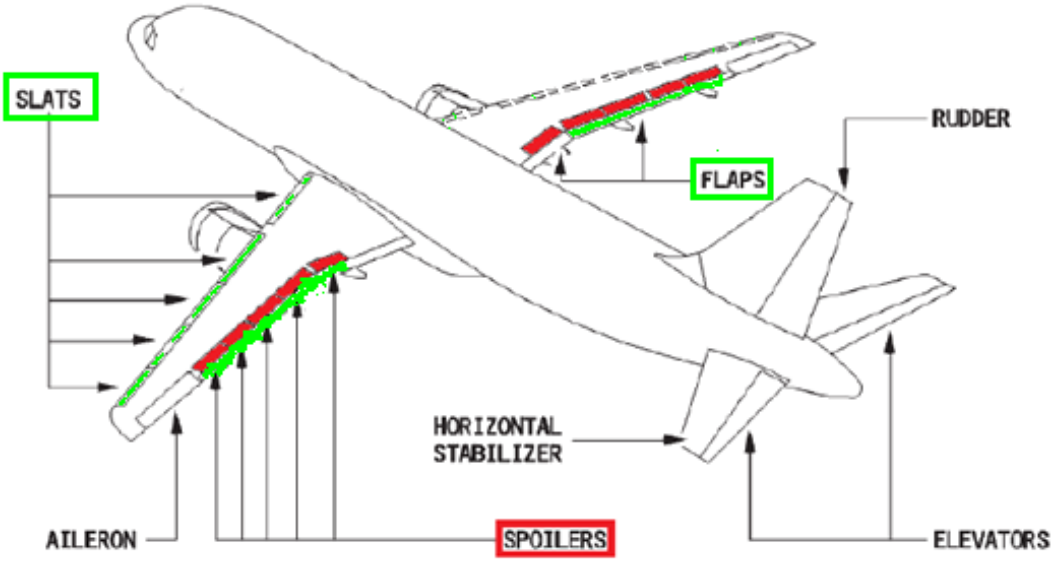
2.4 Flight controls

- The primary control surfaces enable the flight control around three axes: elevator, rudder and ailerons.
- The secondary control surfaces are speed brakes, spoilers, high-lift devices.
- Of course primary controls are essential not only for the completion of the mission, but also for safety; therefore they are characterized by a high redundancy and reliability; furthermore they are able to keep the top performance even with faults in the system.
- Location of the primary controls of direction, depth, roll and stabilization.

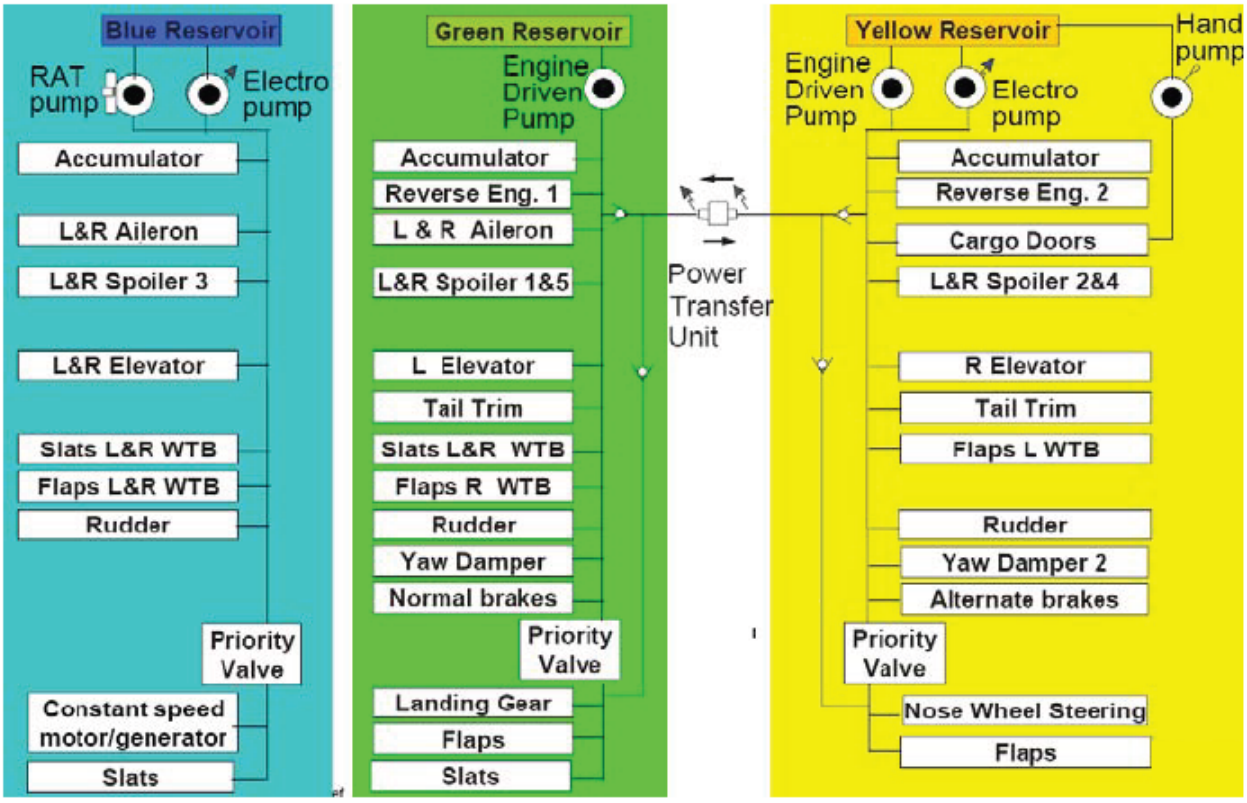




- Location of secondary controls which modify the aerodynamic configuration:
  - slats and flaps, for lift
  - spoilers, for resistance

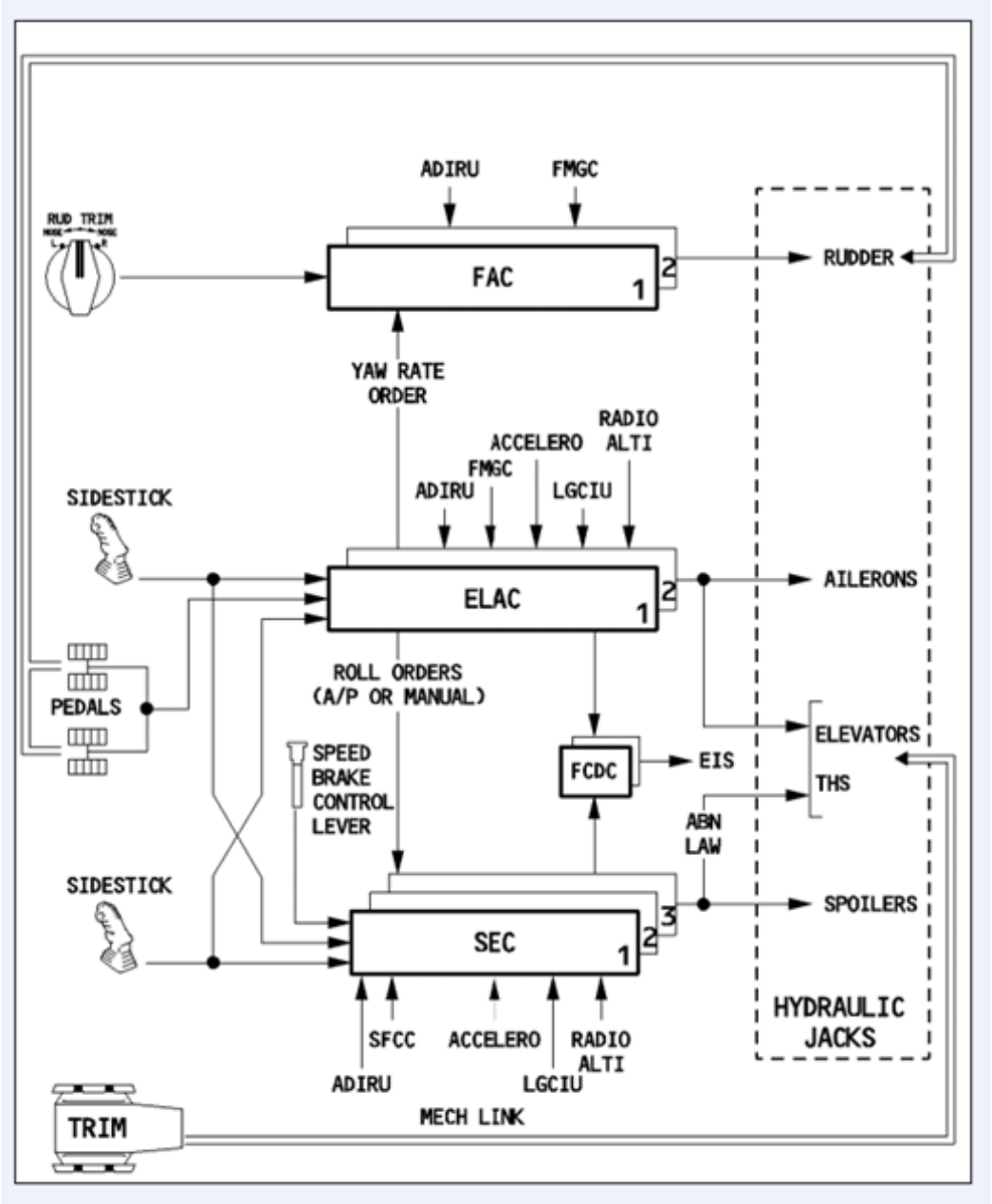


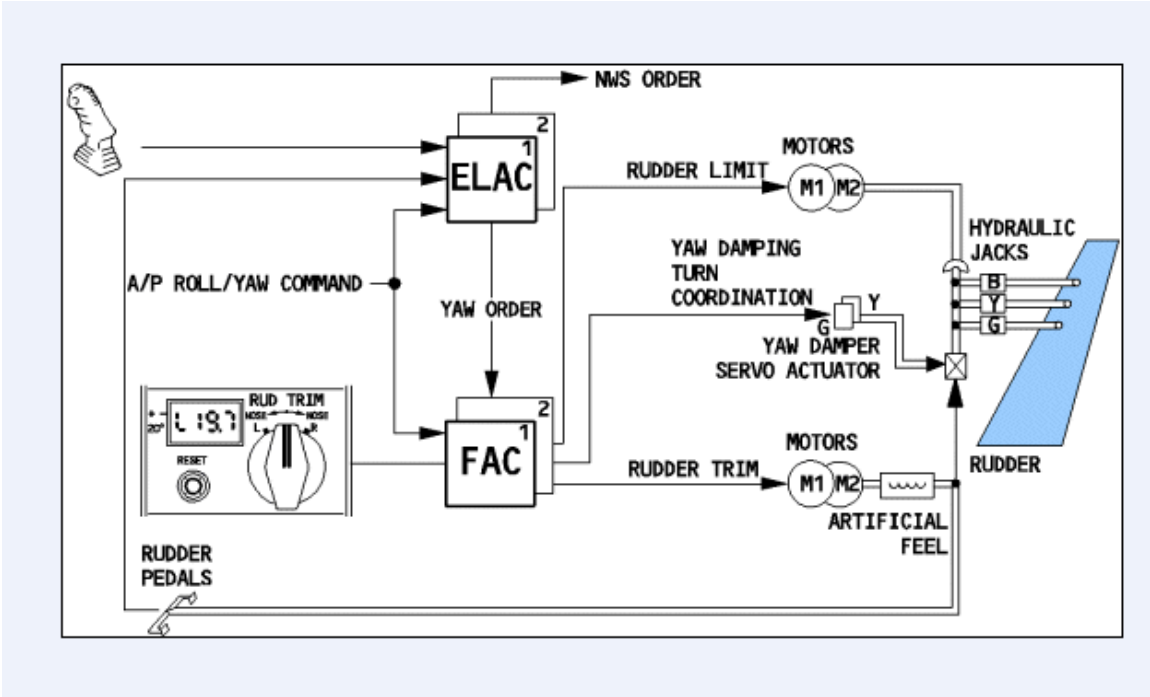
Distribution of the controls in each hydraulic circuit.

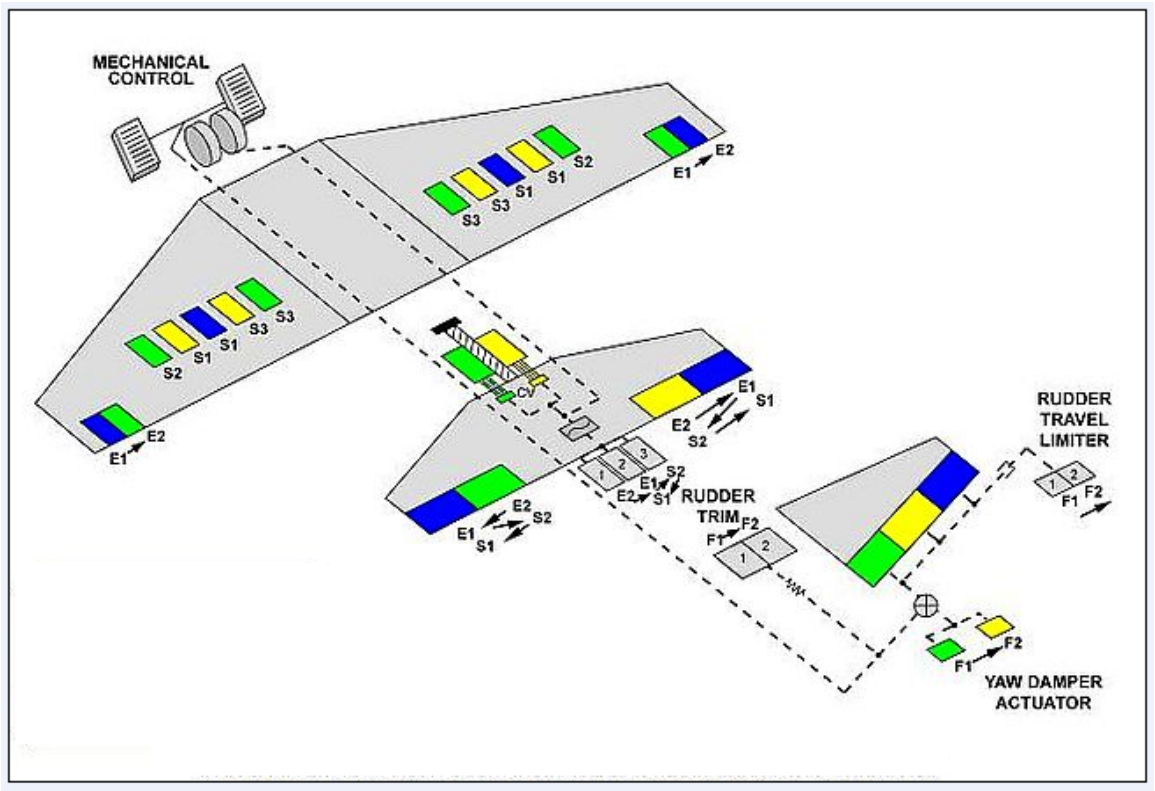


2.5 Flight control units

- Primary flight controls are managed by one or more computers.
- In case of any fault, an emergency computer starts operating.
- This control is carried out by the following computers:
  - 2 ELAC (Elevators and Ailerons computers)
  - 3 SEC (Spoilers and Elevators computers)
  - 2 FAC (Flight Augmentation computers)



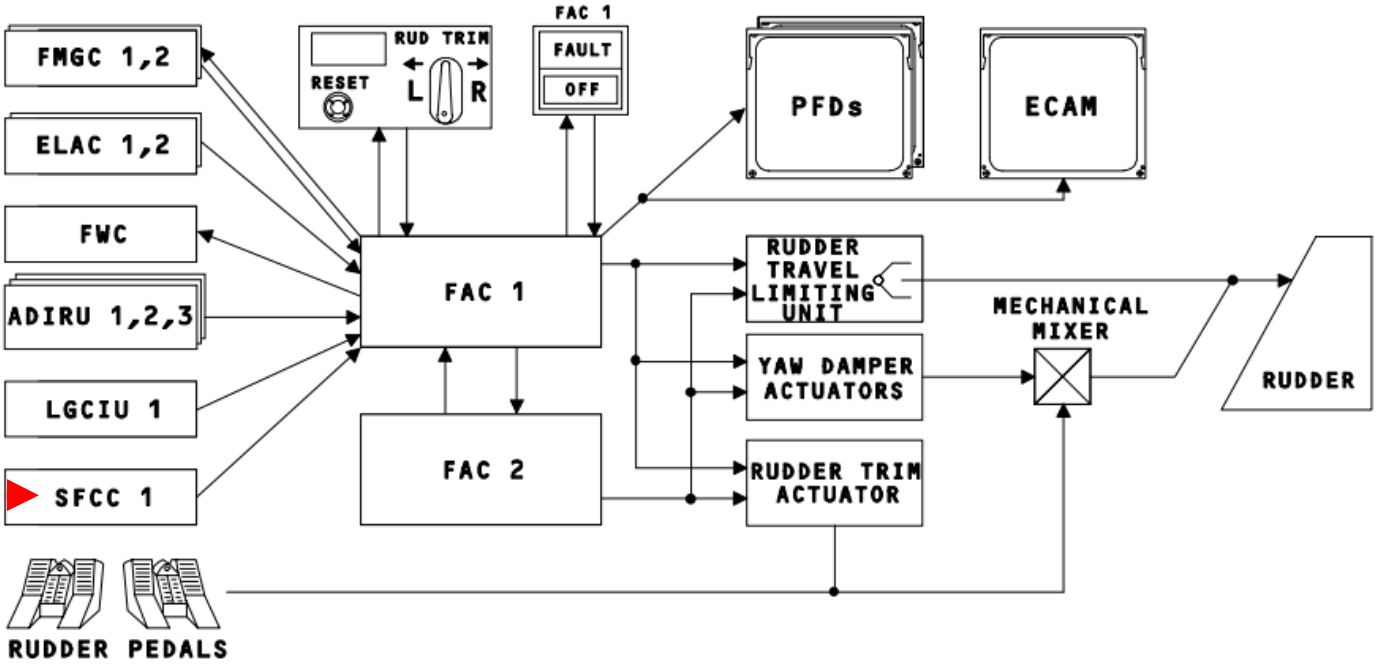




E = ELAC
S = SEC
F = FAC

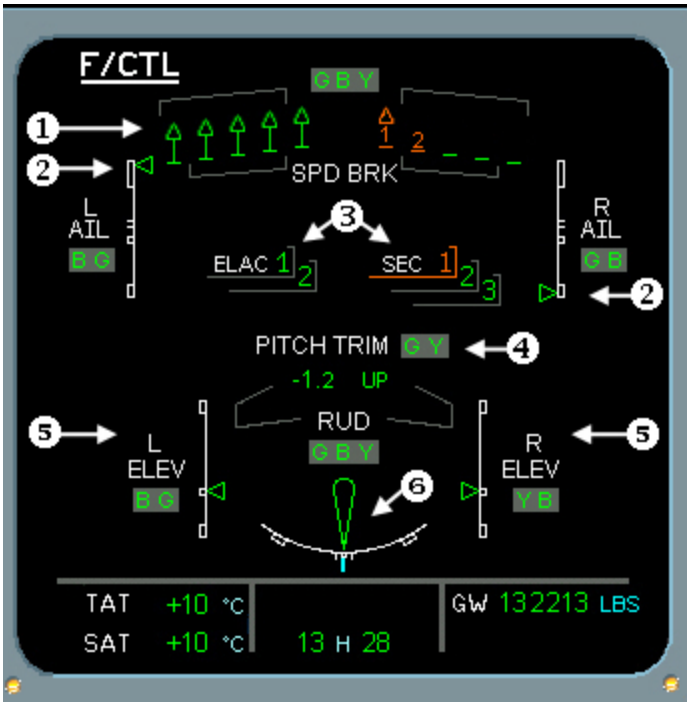
→ The arrow indicates the new configuration in case of fault (for primary controls)

- The secondary controls are managed by two computers:
- In case of any fault, the emergency computer starts operating.
- This control is carried out by the following computers:
  - SFCC 1 (Slat and flap computer) and SFCC2 which send the data to computer FAC1 (refer to the diagram)



FLIGHT CONTRO DISPLAY (Cockpit)

1. SYMBOLS OF SPOILERS/SPEED BRAKES



- Spoiler extended

- Spoiler rectracted

- Fault in the extended spoiler

- Fault in the rectracted spoiler

2. DISPLAYING “AILERON” POSITION (AIL)

The scale is displayed in white and the position indicator in green.

3. DISPLAYING ELAC AND SEC COMPUTERS

The number of the computer is displayed in green and its typology in white. In case of breakdown the colour of the number becomes amber.

4. DISPLAYING “PITCH TRIM” POSITION

Pitch trim is displayed in white and it becomes amber when locked. Cylinders G and Y are displayed in green, their colour becomes amber when the hydraulic pressure is too low.

5. DISPLAYING THE “ELEVATOR” POSITION

The scale is displayed in white and its position by a green indicator

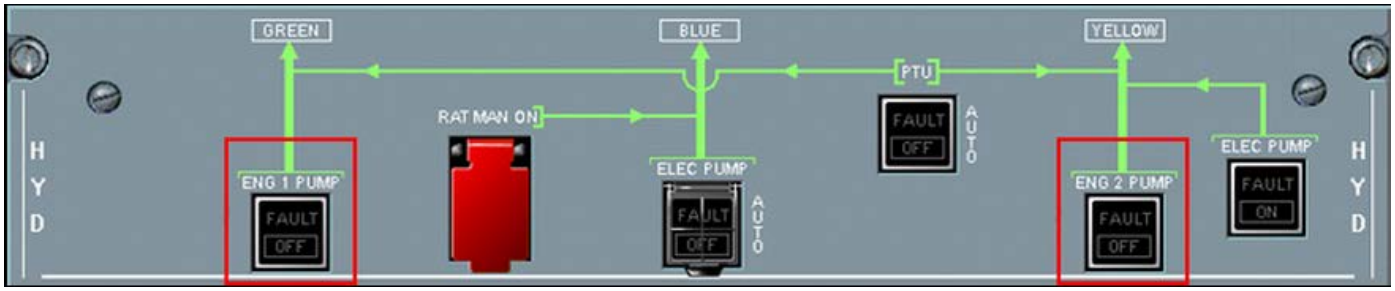
6. DISPLAYING THE “RUDDER” POSITION

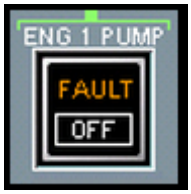
It is displayed in green, The “rudder” symbol and the scale become amber when the pressure is too low in the three hydraulic circuits.

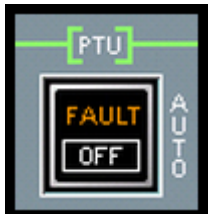
2.6 Setting the hydraulic circuit at work and displaying its operation

- The controls of the hydraulic circuit are available in the “Upper Head Panel” with their buttons and the display of their state, if necessary:

  - Engine 1
  - Engine 2
  - Electric pump (BLUE)
  - Electric pump (YELLOW)
  - PTU (Power Transfer Unit)
  - RAT (Ram Air Turbine)



	- When the pump is off, the LED OFF (White colour) of the button is on. - When the pump ENG PUMP1 1 is ON, the LED of the lower part of the button is kept off. - The LED of the button indicating the state is kept off or it indicates FAULT (amber colour) when: - the oil level in the reservoir is low - the oil temperature is too high - the oil pressure in the reservoir is too low

	- When the PTU is off , the LED OFF (White colour) of the button is on. - When the PTU is enabled (mode AUTO), the LED of the lower part of the button is kept off. - The LED of the button indicating the state is kept off or it indicates FAULT (amber colour) when: - the oil level is low - the oil temperature is too high - the oil pressure is too low, in the GREEN and YELLOW circuits

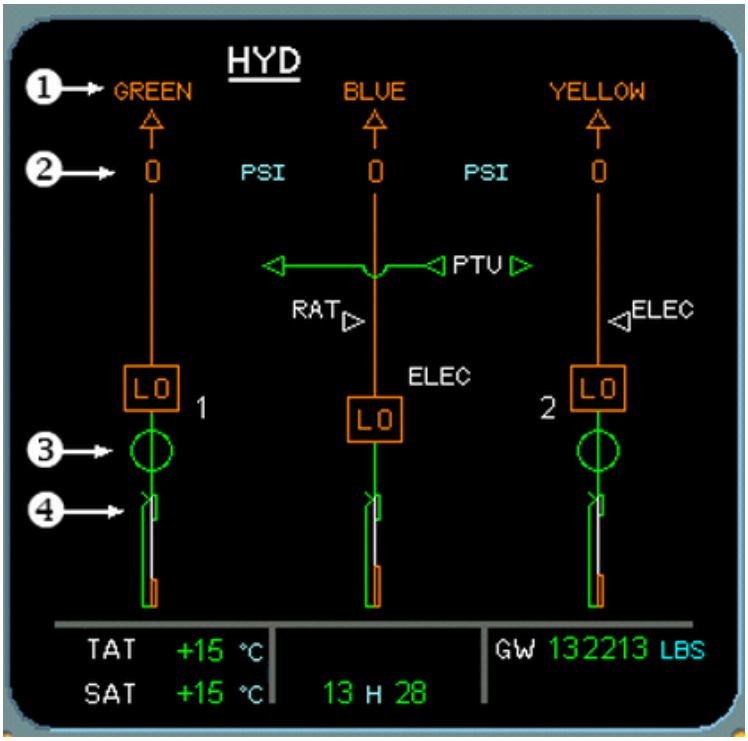
- Displaying the hydraulic circuits before starting the engines.

1 the colour depends on the pressure:
- it is green if pressure is normal, that is 3000 psi (pound/inch²) = 206 bars
- it becomes amber when pressure is too low

2 Value of the pressure in the circuit

3 The symbols of fire valves are green, when these valves are open, and amber, when they are closed

4 Level of fluid



- Displaying the hydraulic circuits after the starting of engines.

  1 State of the Ram Air Turbine (RAT):
  - white coloured, if it is closed
  - green coloured, if it is ON
  - amber coloured, if it is extended, but not operating

  2 State of the hydraulic pump

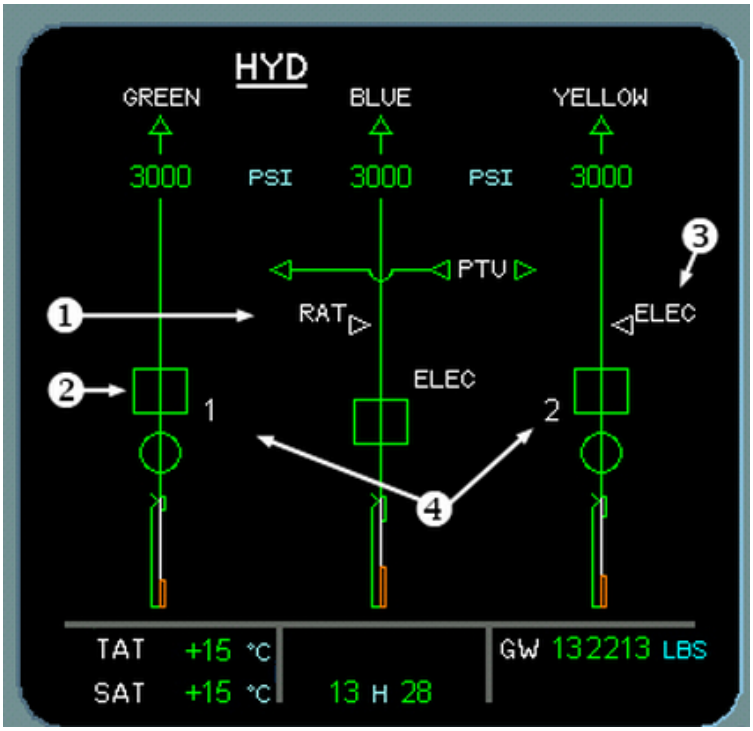
   The pump is running at normal pressure

   The pump is off

   The pump is running at low pressure

  3 State of the electric pump
  - white coloured, if it is OK
  - amber coloured, when there is some trouble in feed line

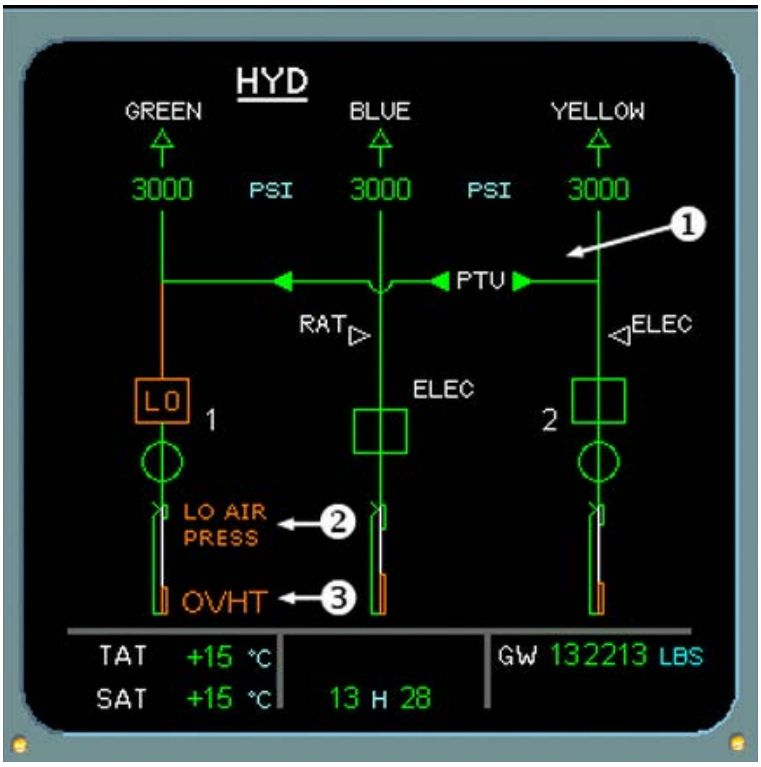
  4 State of the pump: green coloured, if it is OK; amber coloured, if it is in neutral



- Action of the Power Transfer Unit

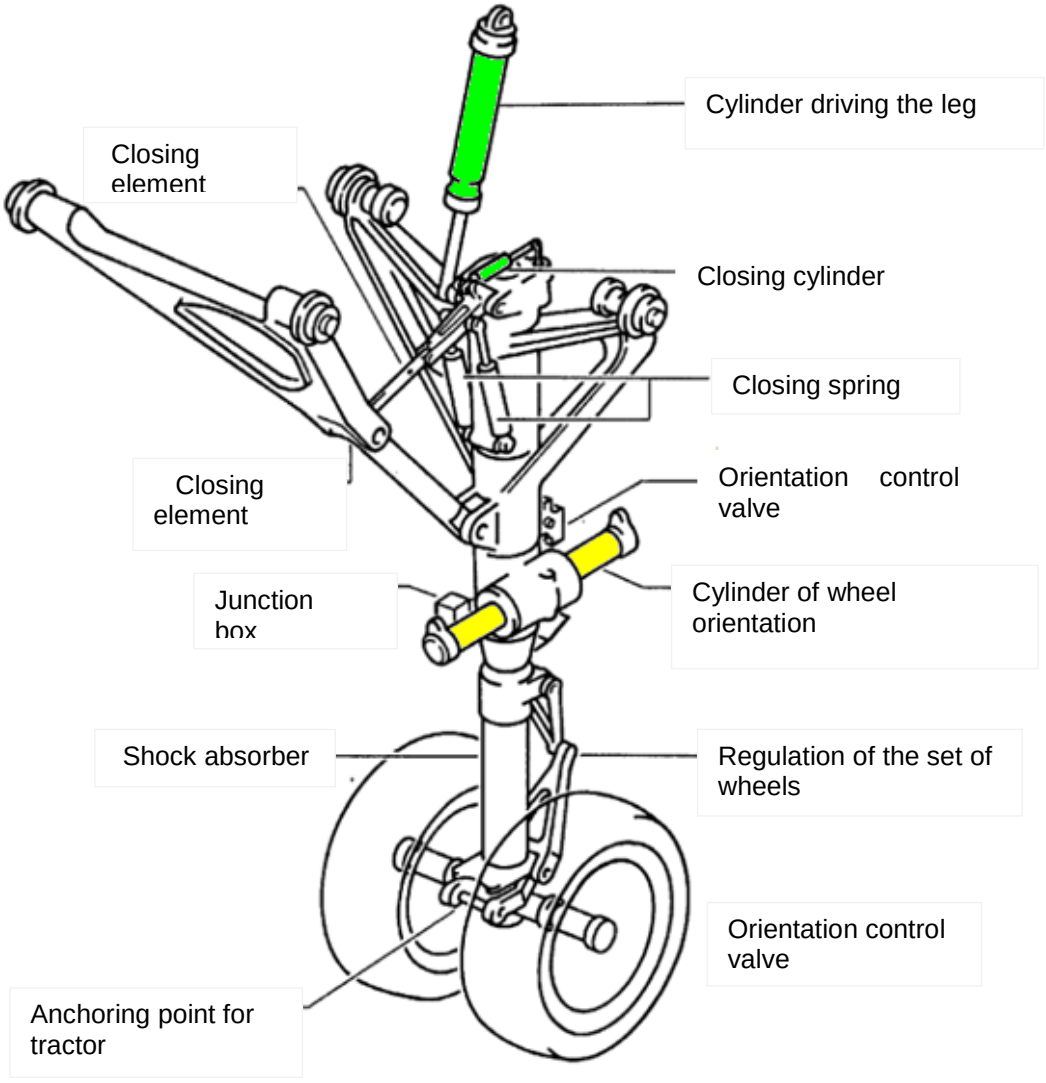
1 in this example, the PTU Control pressurizes the green hydraulic circuit automatically, as soon as the pressure difference exceeds 500 PSI;
2 then it is set at work when the pressure in the reservoir is too low;
3 the symbol of the reservoir becomes amber when temperature is too high.

In this example, the pump of the green circuit is off and consequently the PTU os set at work to pressurize this circuit.

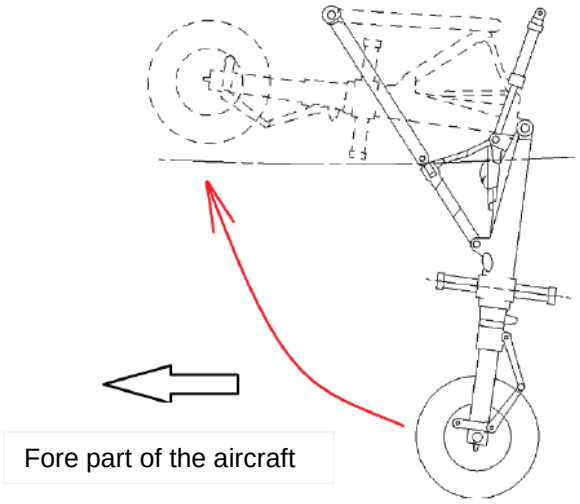


2.7 Landing gear systems

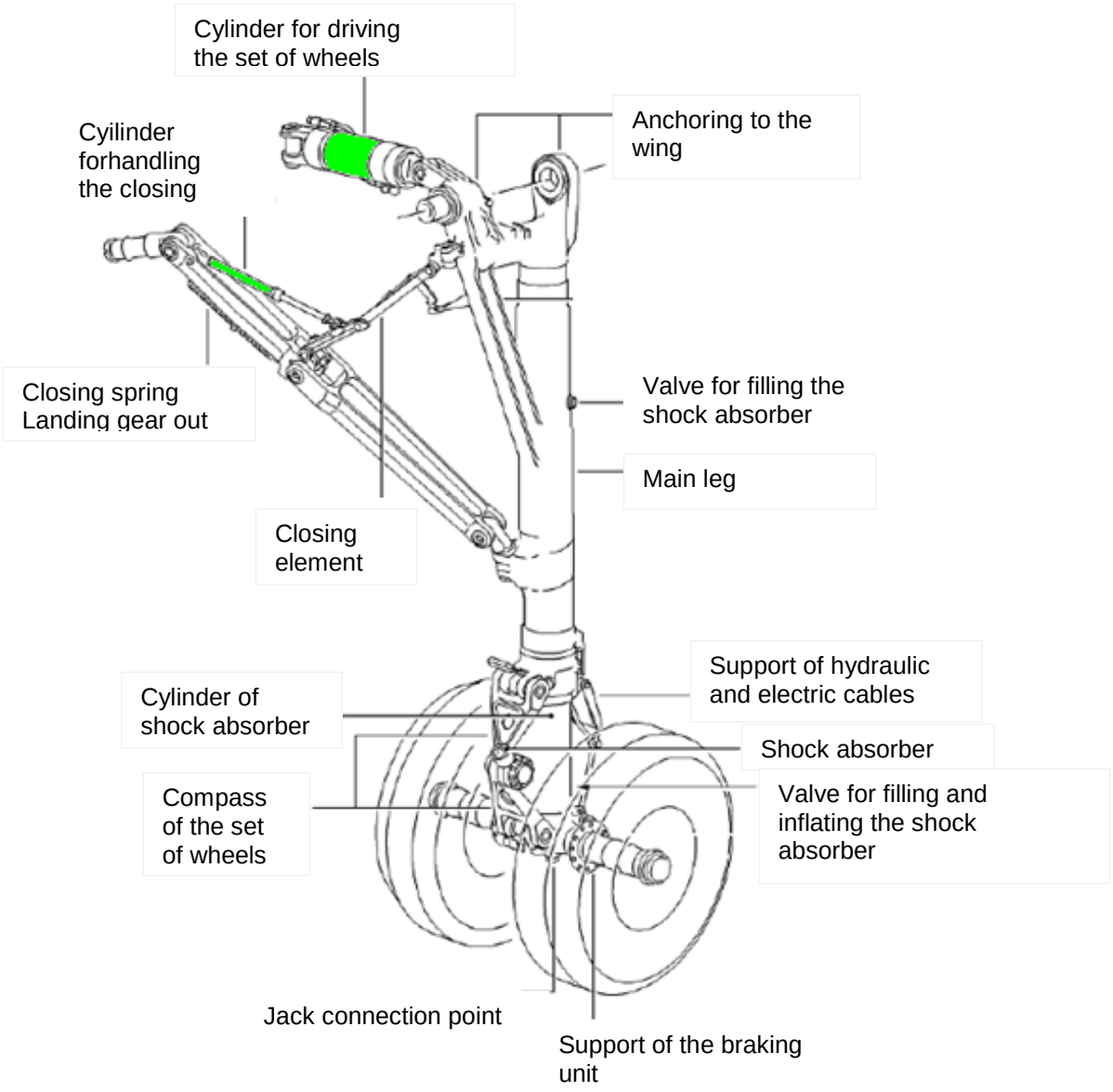
- The landing gear is controlled electrically and driven hydraulically by cylinders
- The fore directional set consists of two unbraked wheels.

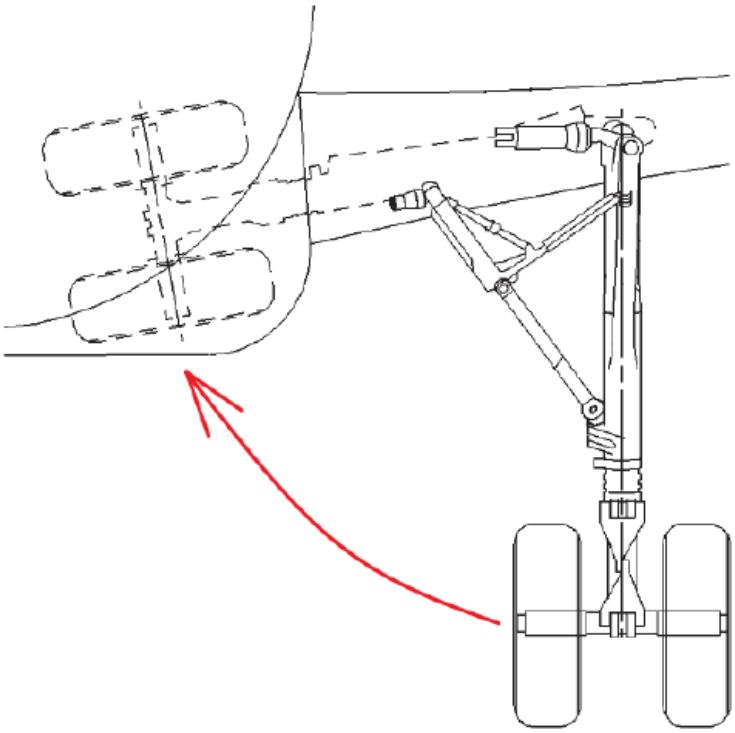


Fore wheel (Nose)

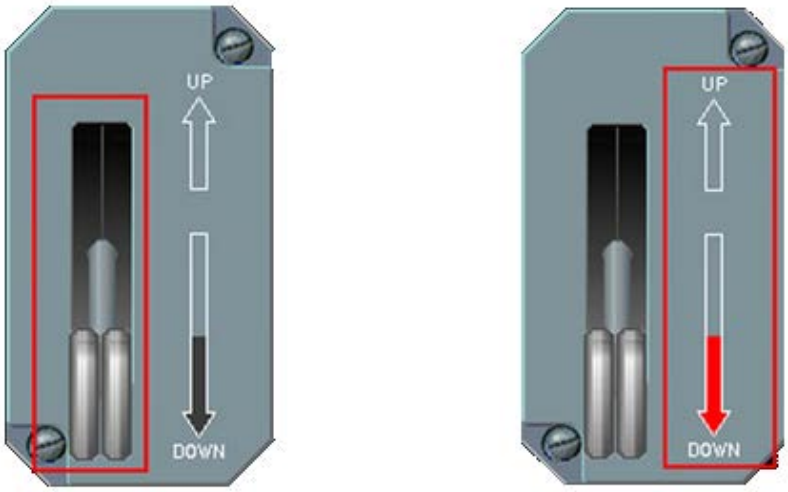


- Main set of wheels (right and left sides)





- The landing gear systems are controlled by two LGCIU (Landing Gear Control Interface Unit) computers
- At the end of each opening and closing cycle of the landing gear the two computers exchange the control.
- Control lever (UP, DOWN) of the landing gear

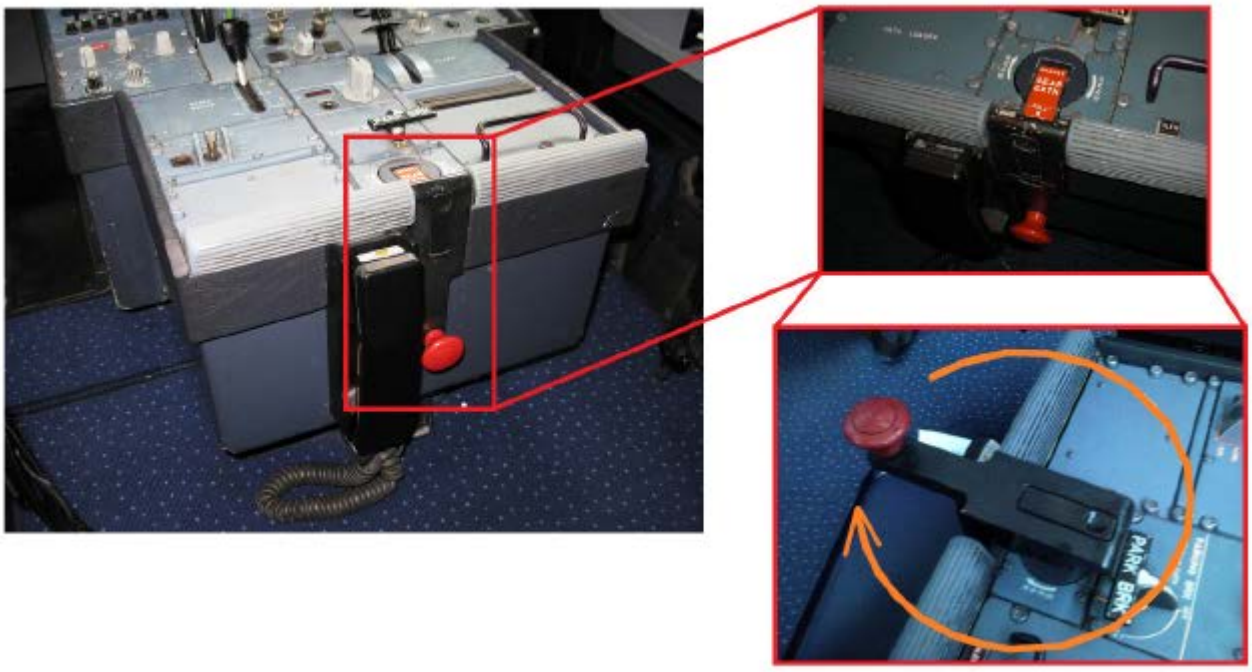


Fault of down movement of the landing gear

- In case of any fault of the opening system of the landing gear, it can be lowered manually by gravity.

- That can occur if there is any leakage in the green hydraulic circuit or any fault in the control computers.

- Turning the red crank available in the cockpit will enable to lower the landing gear by gravity.

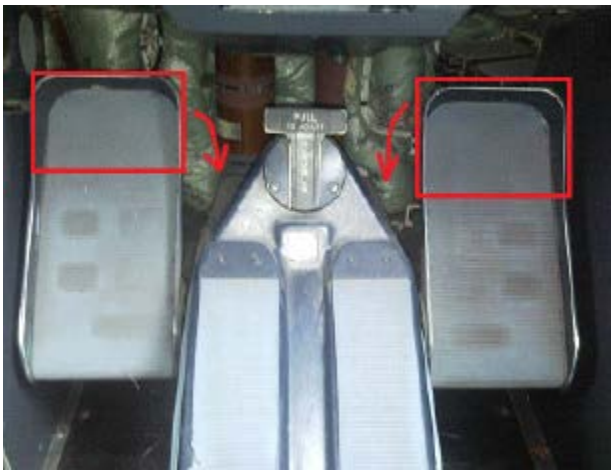


- Turning this crank will also enable to depressurize the hydraulic system of the landing gear and to unlock legs and doors mechanically.

- The landing gear systems are pushed by a spring and by the relative wind.

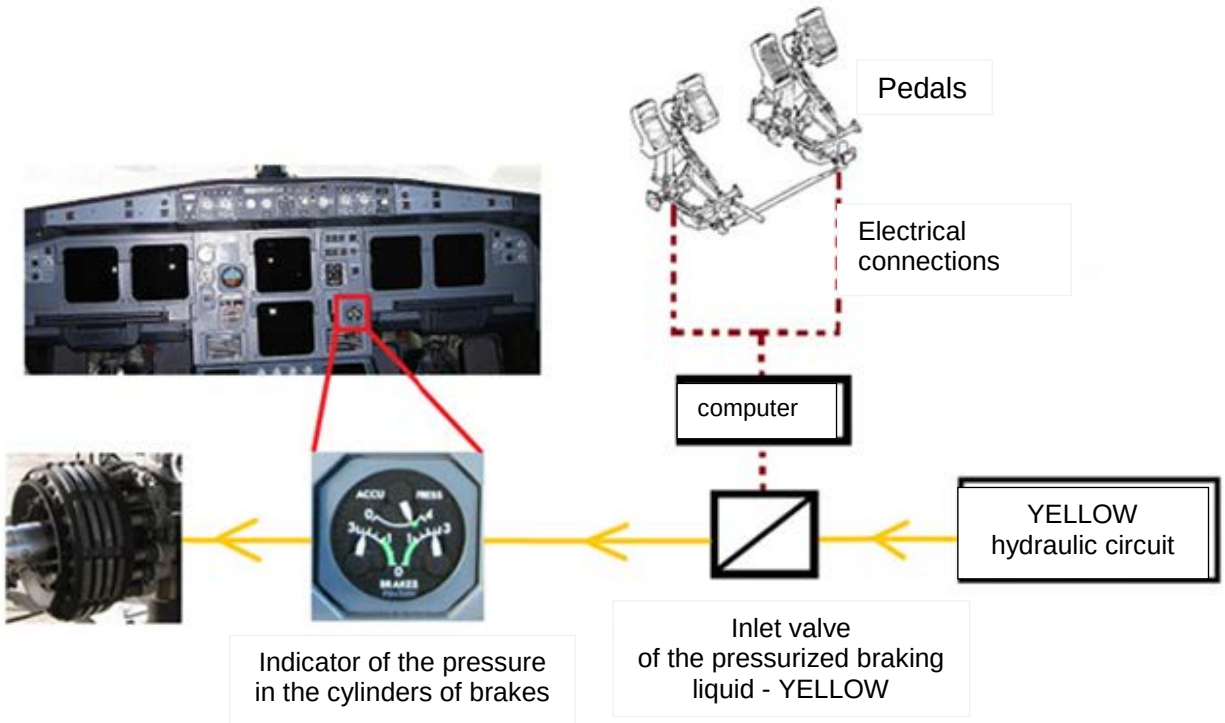
2.8 Braking system

- The normal braking system will use the “green” hydraulic circuit.
- The emergency system will use the “yellow” hydraulic circuit.
- The brakes of the right and left set of wheels are controlled by the aid of two pedals.



- The movements of these pedals are converted into electric voltages sent to the BRAKING CONTROL computers which drive the hydraulic cylinders of the brakes.

- The maximum braking pressure amounts to 1000 PSI (68.9 bars)

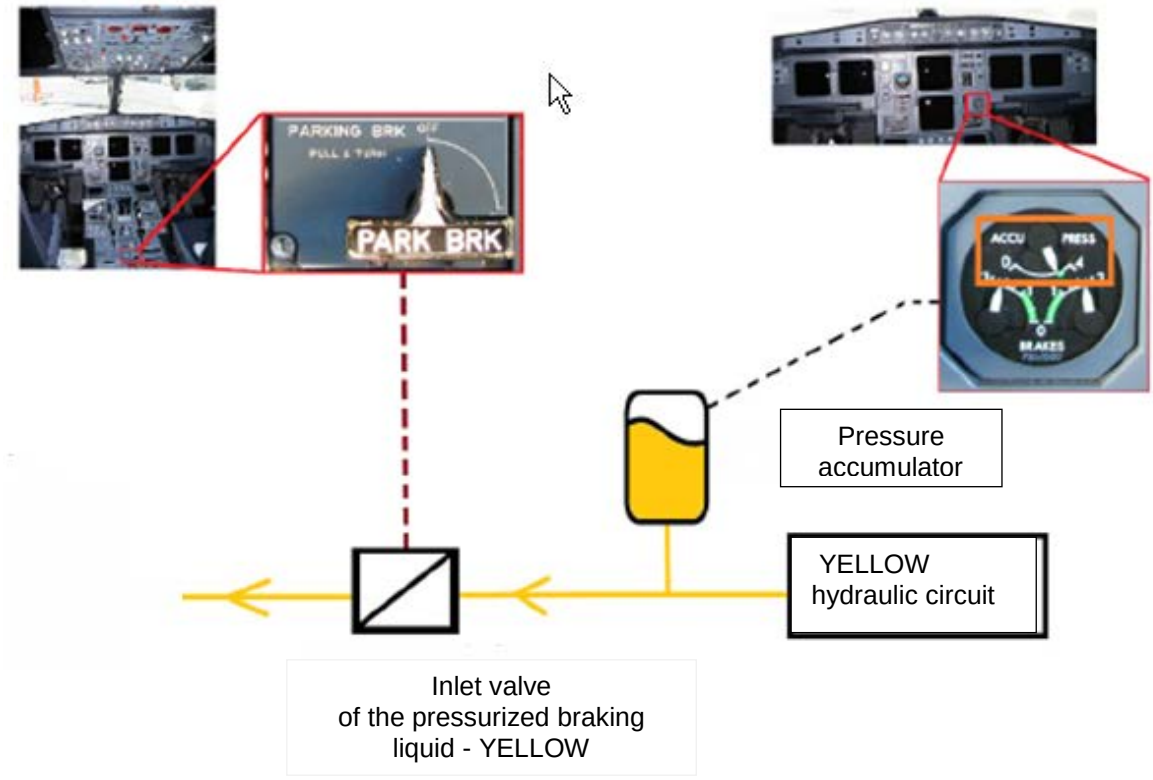


PARK BRAKE

- The “PARK BRAKE” unit will use the brakes of the aircraft with the yellow circuit for the pressurization.

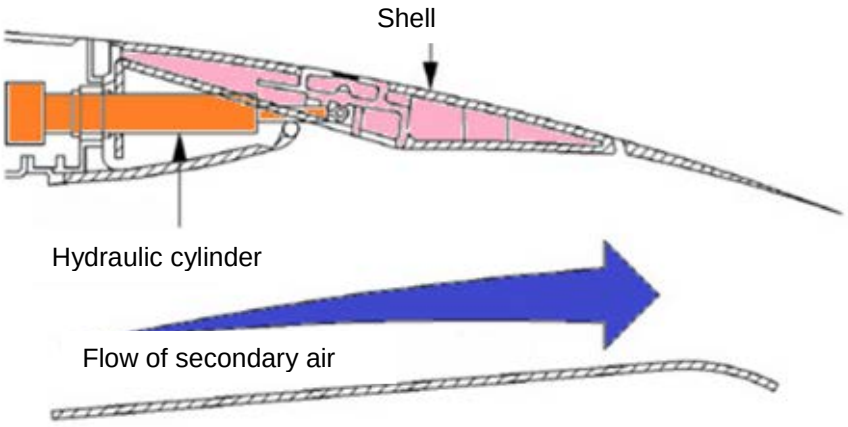
- The park brake will use a hydraulic pressure accumulator.

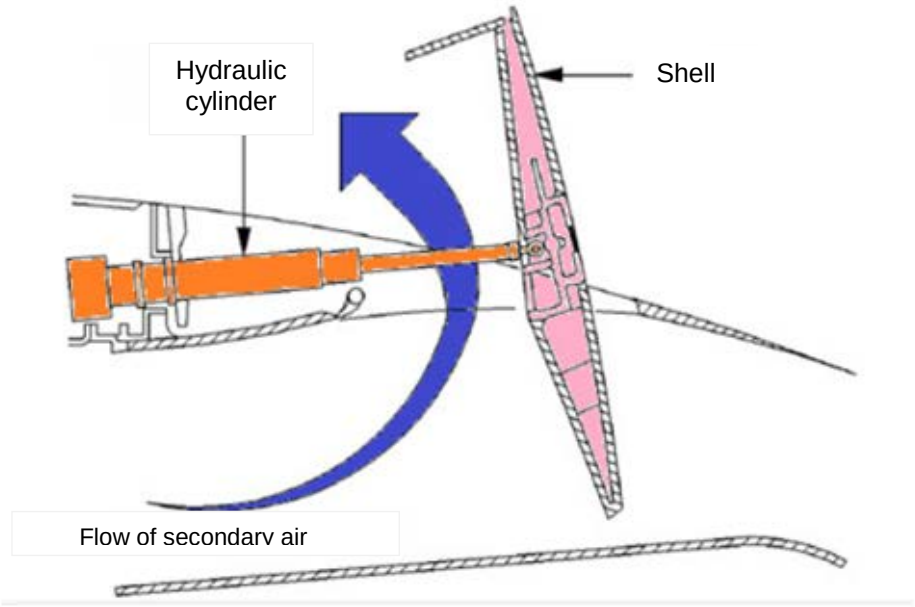
- The PARK brake is controlled by a lever available in the cockpit



2.9 Thrust reverse

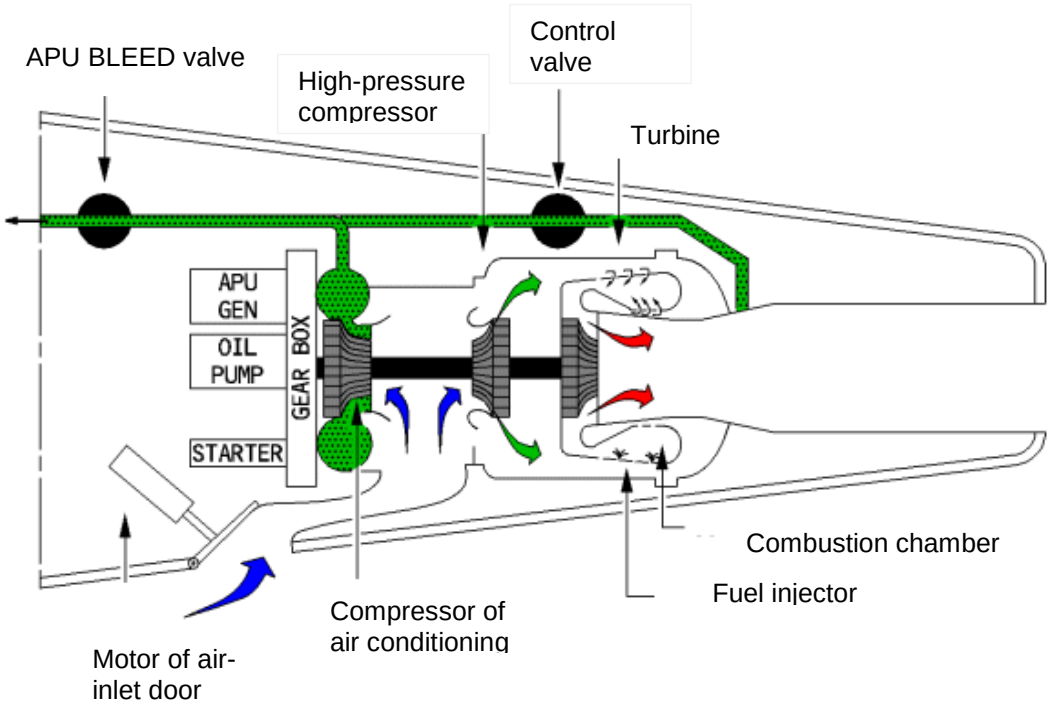
- The thrust REVERSE is used in the braking operations during the landing or stop/take-off phases.
- This system consists of suitable screens (“clam-shells”) whose extension or retraction is controlled from the cockpit. Thus the flow of the secondary air (cold flow of the turbo-fan) is stopped mechanically and deviated of a certain angle forwards in the direction opposed to the advancement.
- The left reverse is driven by a cylinder using the green hydraulic circuit.
- The right reverse is driven by a cylinder using the yellow hydraulic circuit.



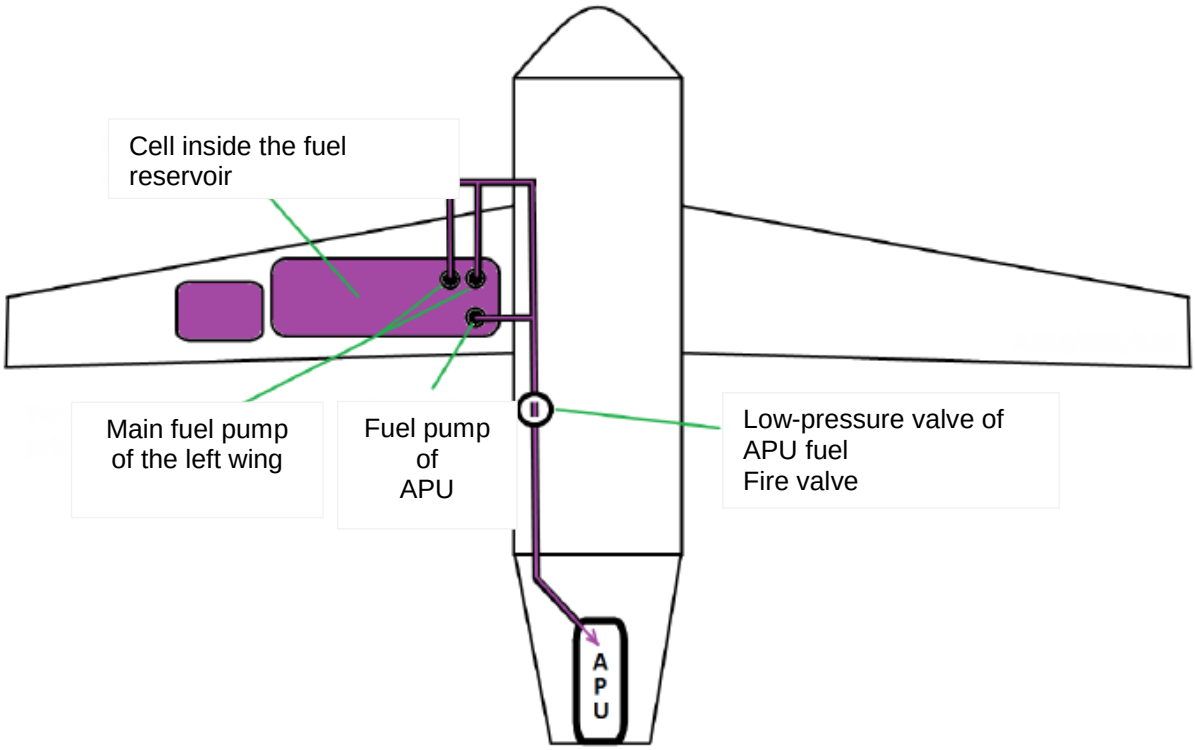


2.10 Auxiliary Power Unit (APU)

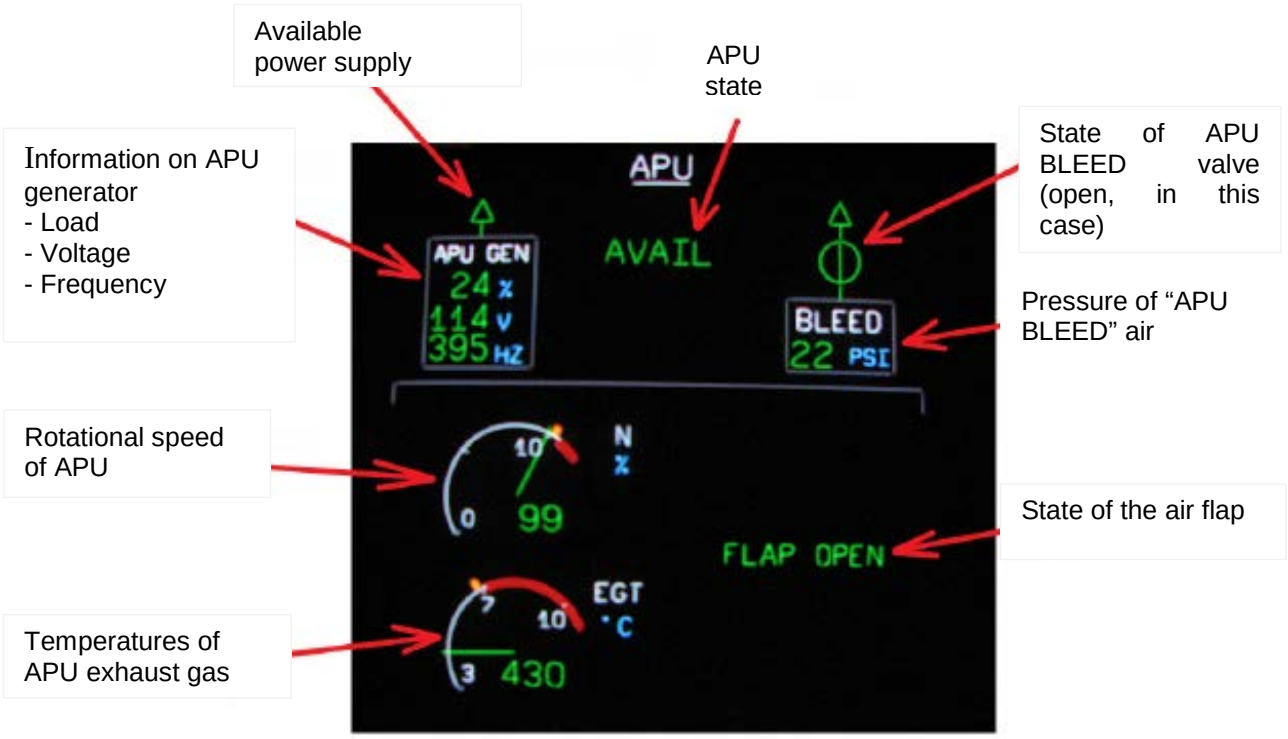
- The Auxiliary Power Unit (APU) consists of a turbine installed in the tail of the aircraft. It enables the aircraft to be independent as regards the electric and pneumatic energy.
- The APU supplies the air for starting the engines and for air conditioning, besides controlling a generator which outputs electric energy.
- Pressing the START button will set this unit at work.
- During the take-off phase it supplies the air conditioning to avoid the power reduction of engines.
- The APU can be used either on the ground and during the flight.
- The inlet air entering the high-pressure compressor is mixed with the fuel.
- After ignition, the cycle is maintained by the expulsion of hot gases through the turbine mounted on the same axis of the compressor.
- The APU is available in the tail cone, with two access doors for the servicing operations.
- Its operation is controlled by the Full Authority Digital Electronic Control (FADEC) used to manage each engine.



- The APU is fed by the fuel coming from the reservoir of the left wing.



- APU control devices are available in the cockpit
- APU supervision is displayed on the screen in the cockpit (ECAM: Electronic centralized aircraft monitor)

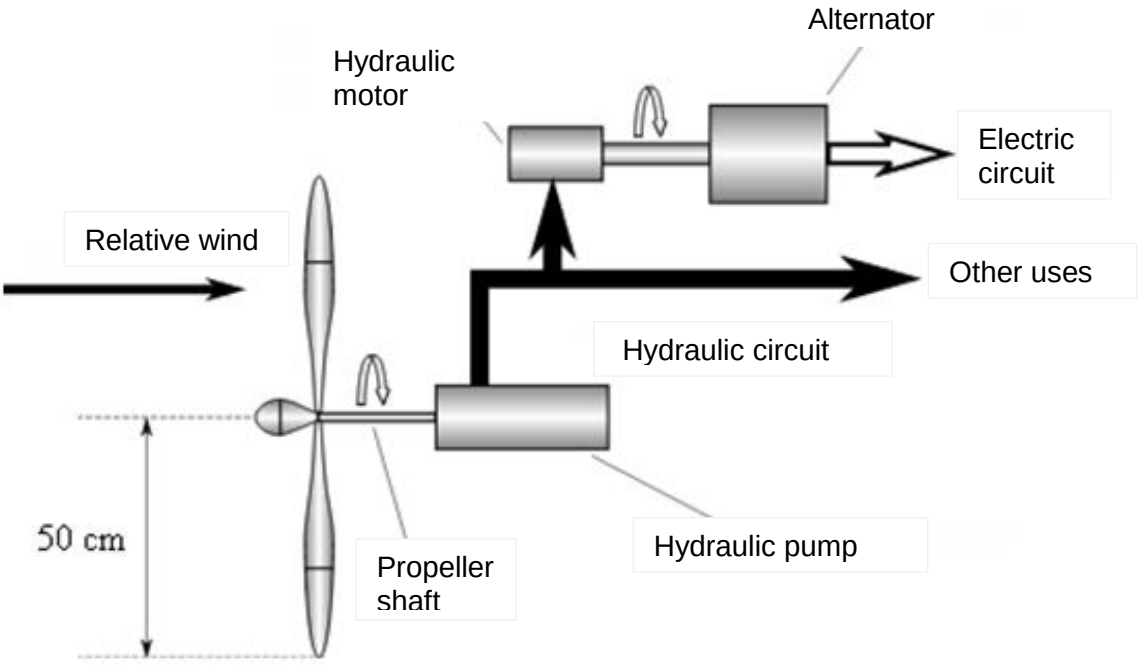


2.11 Ram Air Turbine (RAT)

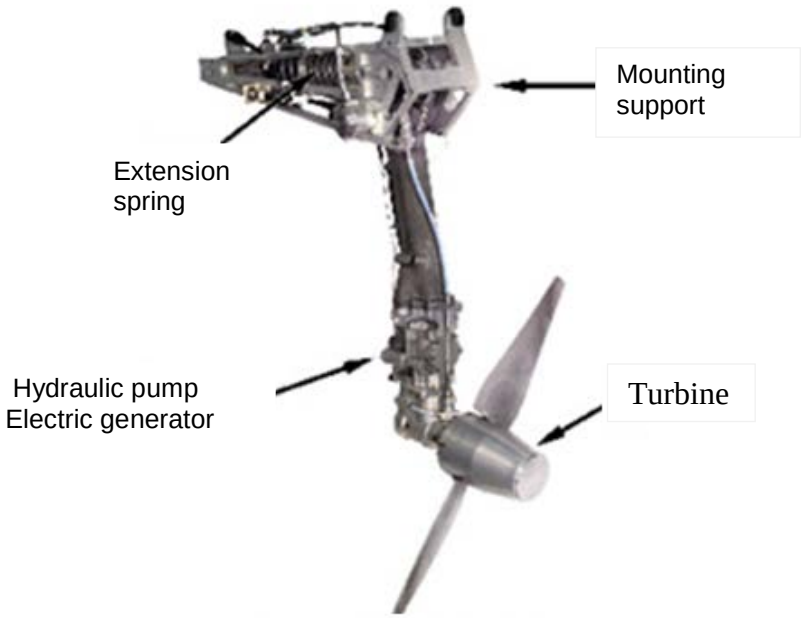
- Several faults can occur during the flight; the Ram Air Turbine (RAT) can manage the most critical faults, that is:
  - Total Flame Out (TEFO)
  - Total Loss of Main Electrical System (TLMES)

- The RAT is a turbine installed in aircrafts which is connected to a hydraulic pump and to an electric generator; thus it is used as energy source. This turbine produces energy because it is hit by the air flow due to aircraft speed: the slower the speed is, the lower the output energy will be. In normal conditions, the RAT is installed in the fuselage or in the wings and it can be extracted manually or automatically in case of total flame out.

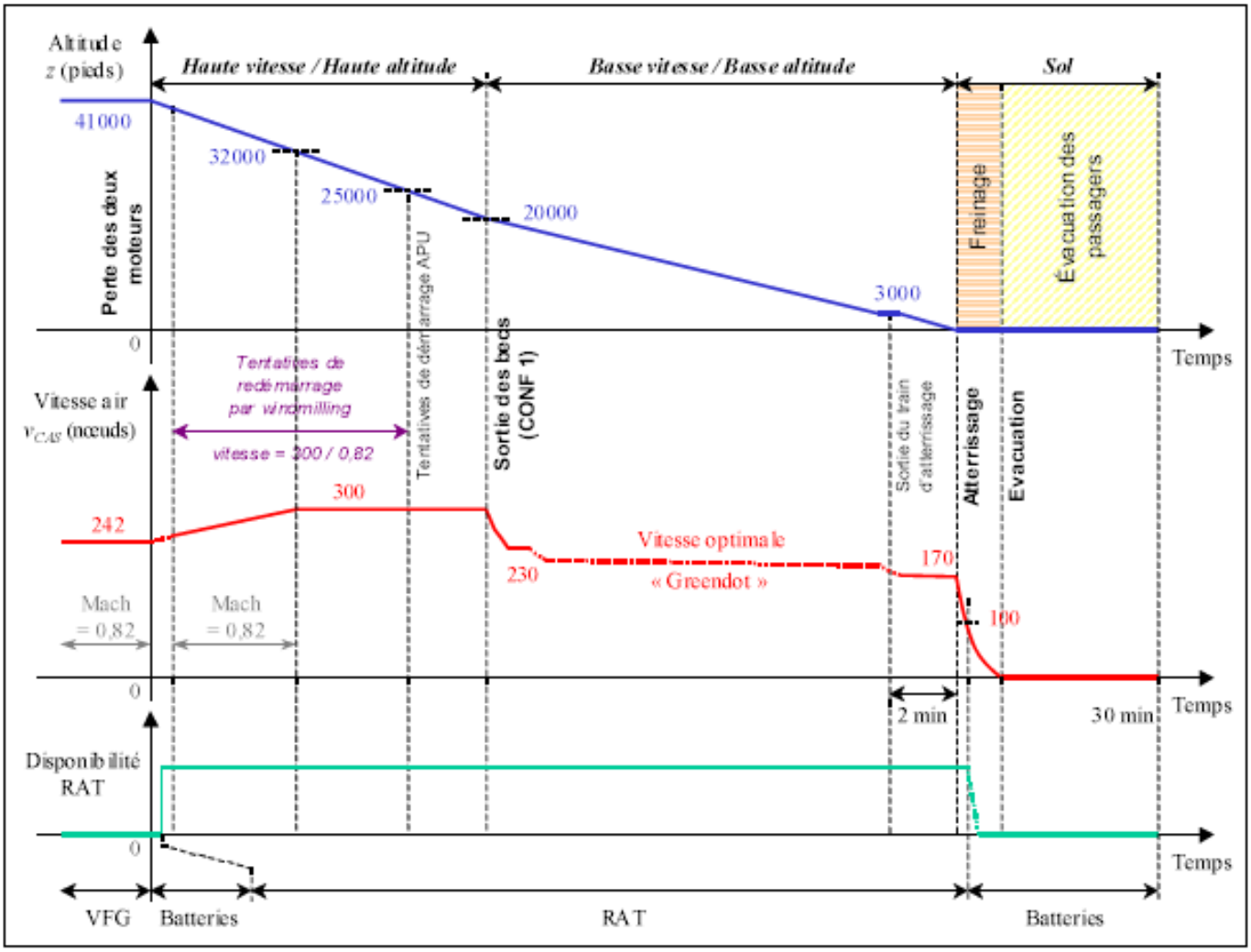
- The RAT is connected to the blue hydraulic circuit



- The output electric and hydraulic energy is used for:
  - the electronic devices of the aircraft
  - the electric control of the cylinders managing the hydraulic system
- Pressure = 2500 psi
- Power supply = 70 kW



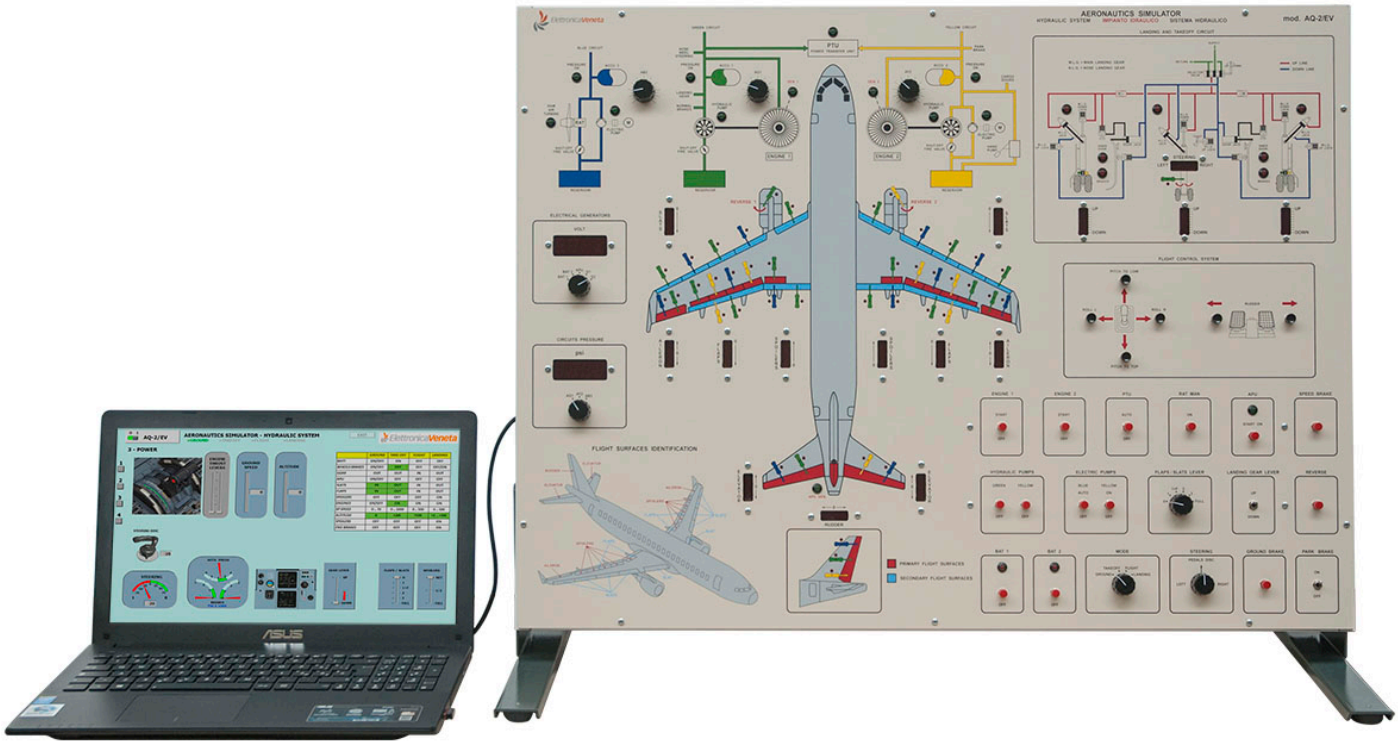
Example of descent (30 minutes) from the total flame out to the landing.



3. SIMULATIONS

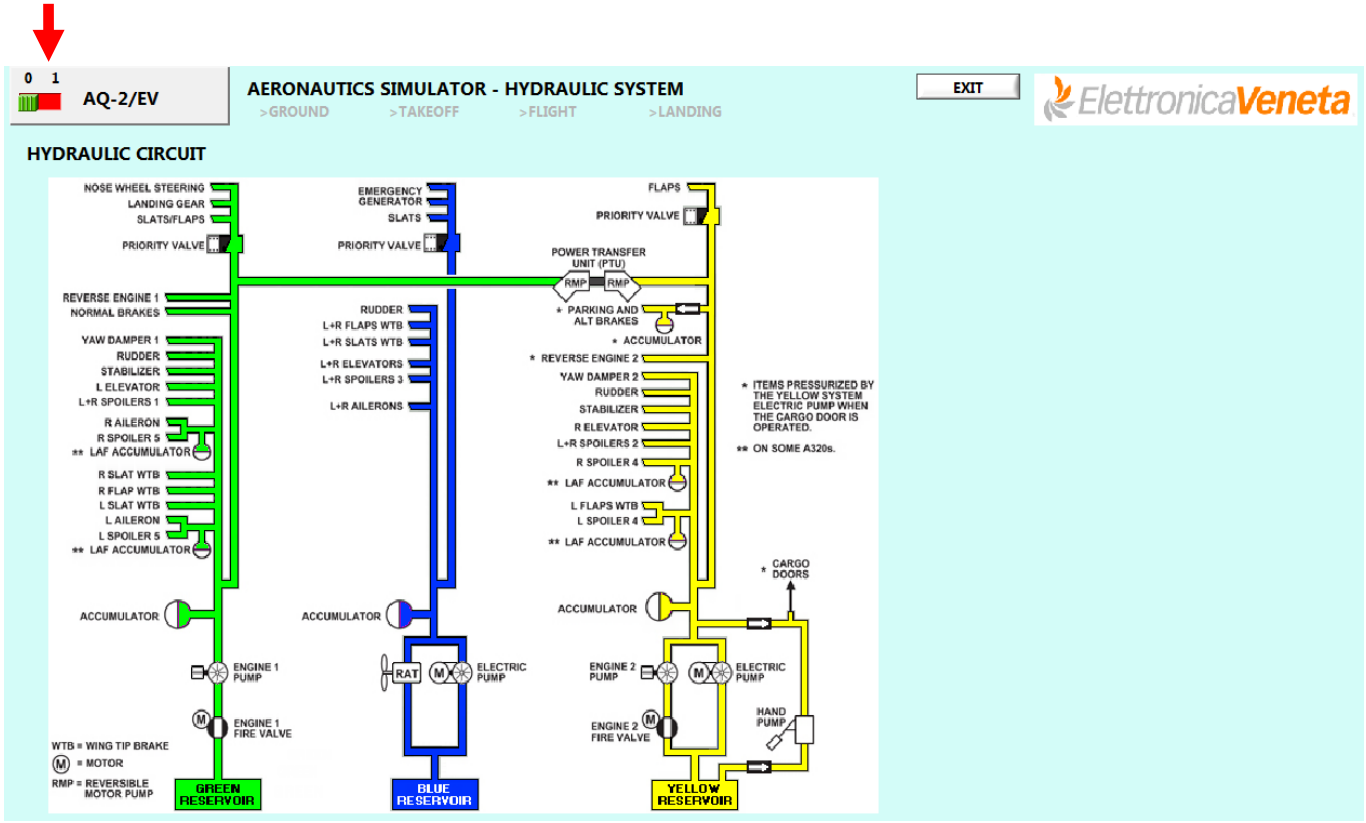
3.1 Introducing the panel

- Power socket (220 V) and on-off switch on the right side
- USB port for the connection to a PC
- Install the control software (refer to section 1.3)



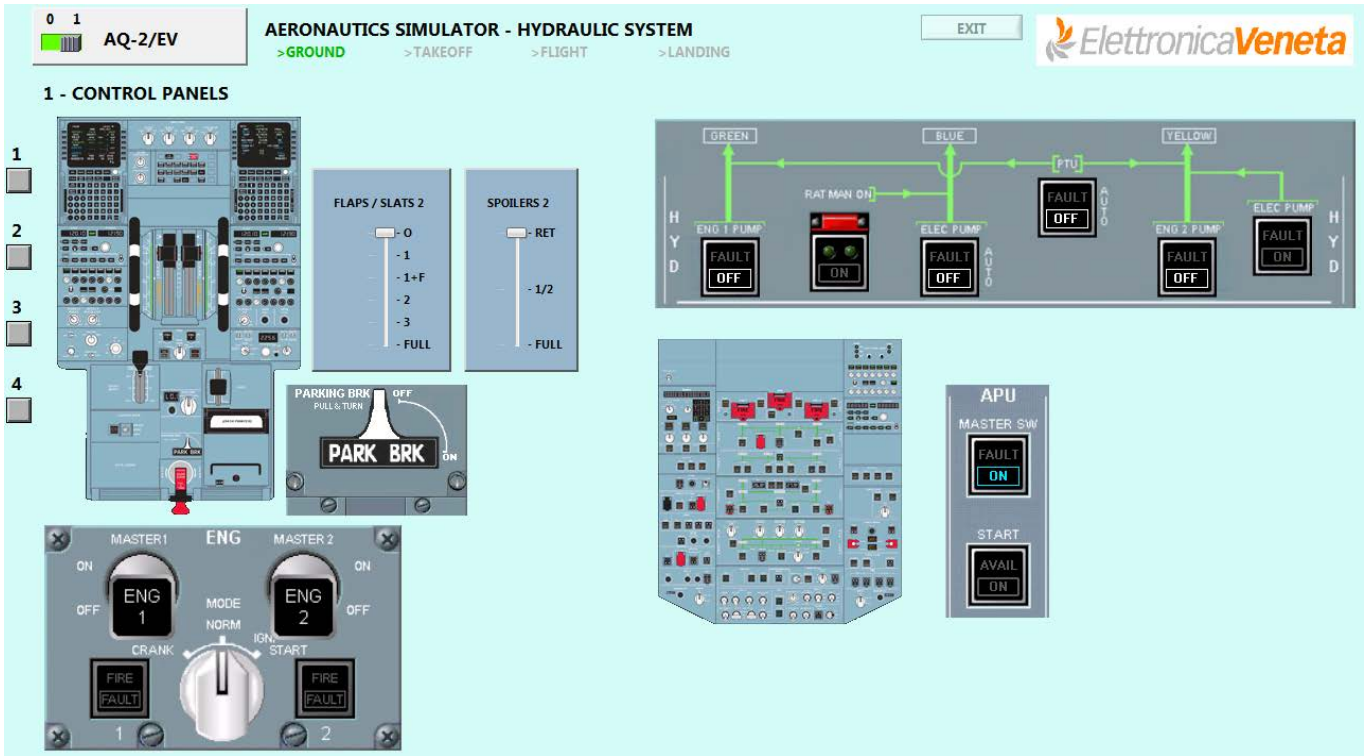
- Click on the icon for booting the control program

- The starting screen with the distribution of the hydraulic actuators is displayed



- Enable the program control by clicking on the button available on the left upper part, with the mouse:
  - Red LED on = disabled
  - Green LED on = enabled

- The starting screen (Button 1) is indicated here below:



- All the control surfaces are in central position, on the simulator.

- The simulator is controlled by:
  - the selector "psi" which enables to display the pressure set in the three hydraulic circuits of the aircraft:
    - Yellow circuit: potentiometer AY2 (0 – 4000 psi)
    - Green circuit: potentiometer AG1 (0 – 4000 psi)
    - Blue circuit: potentiometer AB3 (0 – 4000 psi)

  - 1 bar = 14.5 psi / 1 psi = 0.06 bar

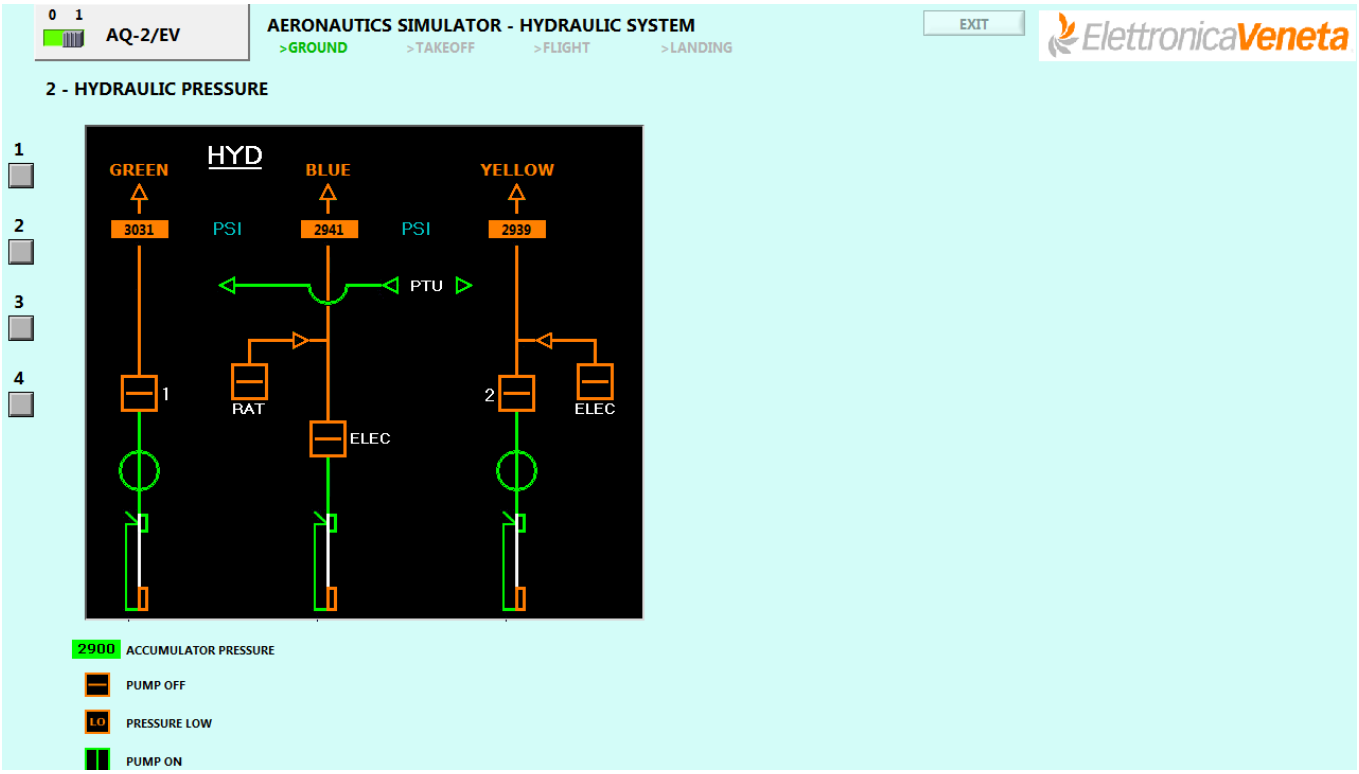
- Selector "VOLT" enables to display the voltage:
  - of battery BAT 1
  - of battery BAT 2
  - of the Auxiliary Power Unit (APU)
  - of generator G1
  - of generator G2

- All the commands controlling the simulations are grouped in the right side of the simulator; these simulations are organized in four MODES:
  - GROUND
  - TAKEOFF
  - FLIGHT
  - LANDING

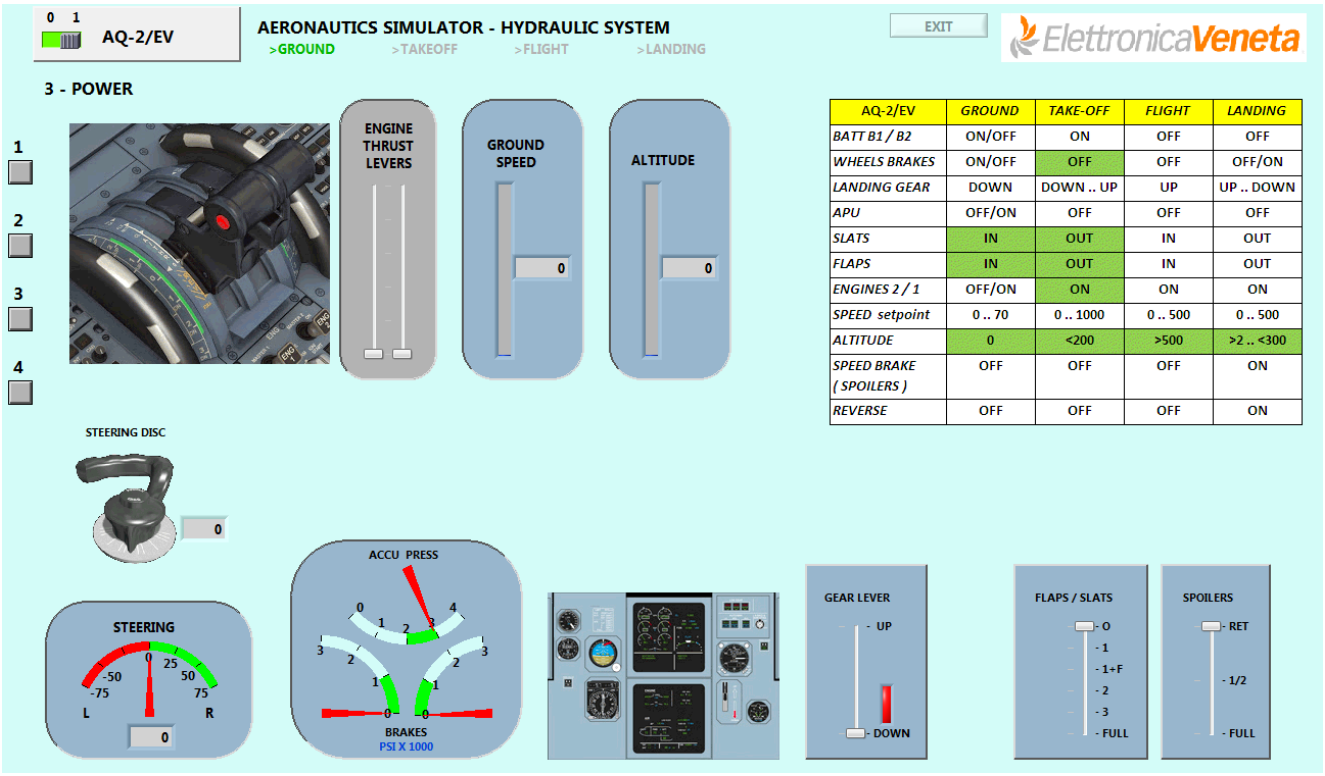
- The four buttons available on the left side of the software enable to display the following screens:

  - Screen 1 : state of APU, of engines and of pumps
  - Screen 2 : supervision of pressures
  - Screen 3: control of flight parameters (speed , altitude)
  - Screen 4: it displays the state (angle) of the primary control surfaces of the aircraft

- BUTTON 2 : Display of the pressures in the three circuits

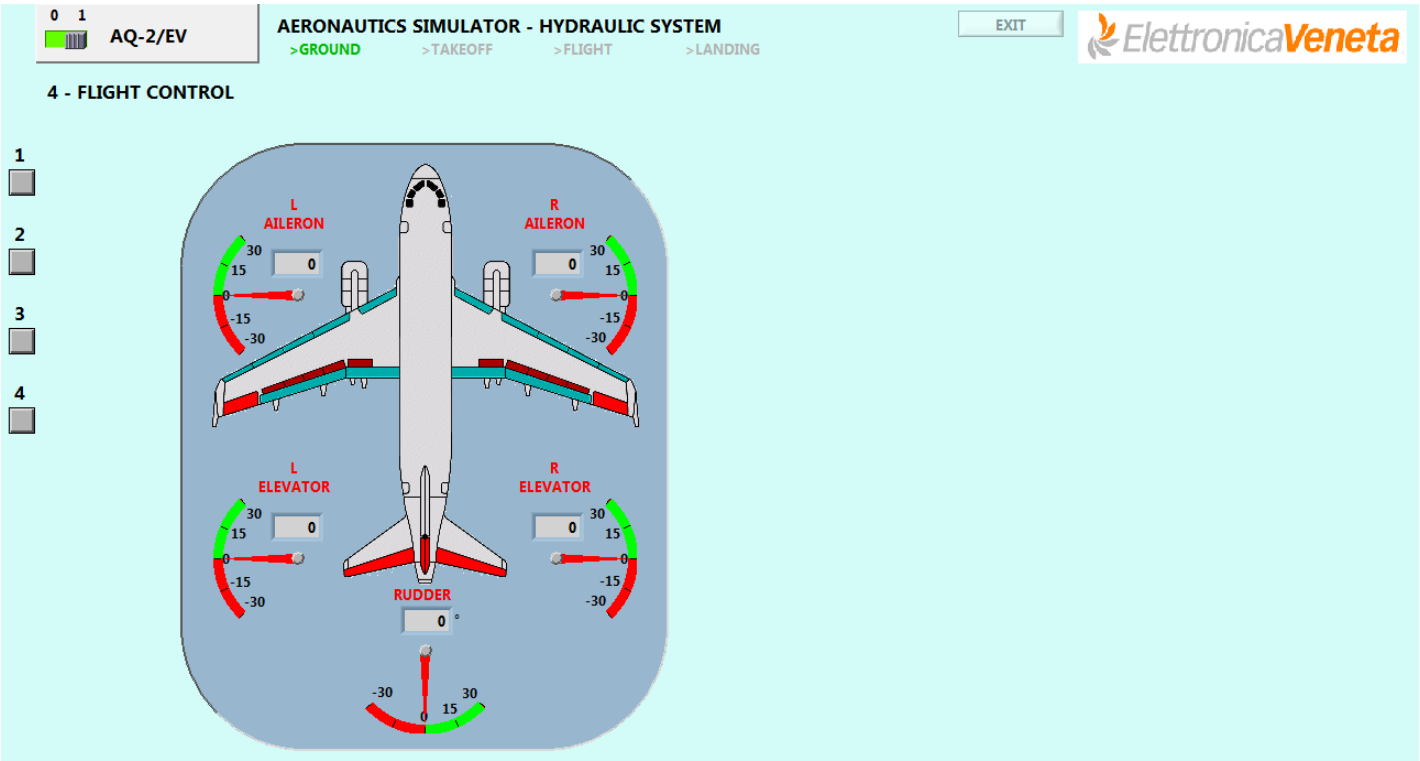


- BUTTON 3: Control of speeds and of altitude
  Reference tables with the values and states of controls



AQ-2/EV	GROUND	TAKE-OFF	FLIGHT	LANDING
BATT B1 / B2	ON/OFF	ON	OFF	OFF
WHEELS BRAKES	ON/OFF	OFF	OFF	OFF/ON
LANDING GEAR	DOWN	DOWN .. UP	UP	UP .. DOWN
APU	OFF/ON	OFF	OFF	OFF
SLATS	IN	OUT	IN	OUT
FLAPS	IN	OUT	IN	OUT
ENGINES 2 / 1	OFF/ON	ON	ON	ON
SPEED setpoint	0 .. 70	0 .. 1000	0 .. 500	0 .. 500
ALTITUDE	0	<200	>500	>2 .. <300
SPEED BRAKE (SPOILERS)	OFF	OFF	OFF	ON
REVERSE	OFF	OFF	OFF	ON

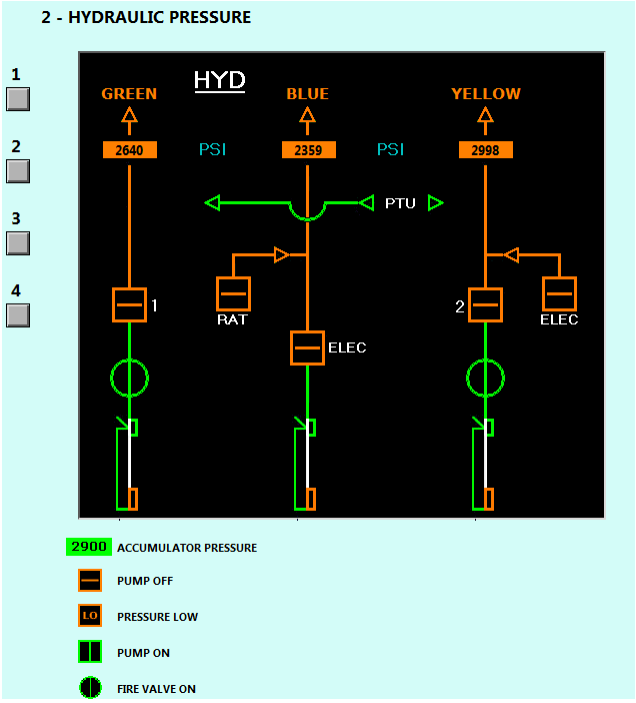
- BUTTON 4: position (angle) of flight surfaces in real time



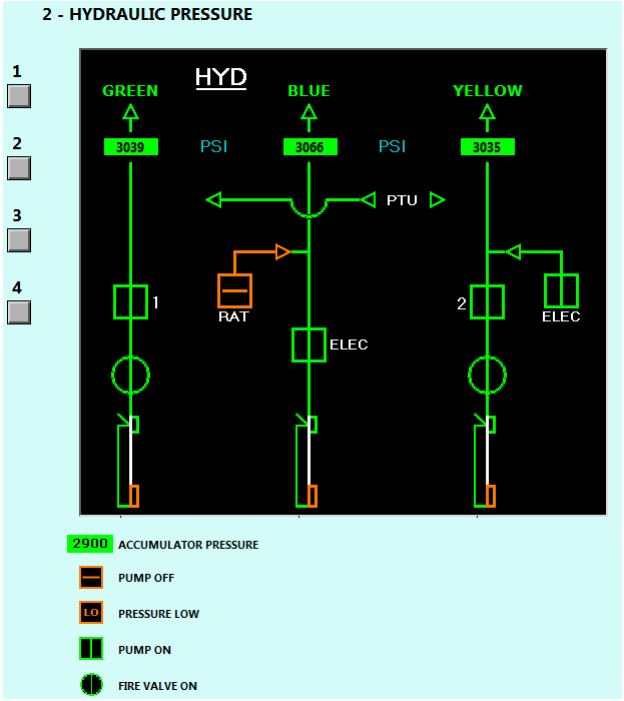
3.2 Starting the engines

- Turn selector “MODE” to GROUND position
- Click on button 1 in the screen of software
- Press button BAT 2 : Red LED on
  > voltage on display VOLT
- Press button BAT 1 : Red LED on
  > voltage on display VOLT
- **Press button APU: Green LED on**
- Press button ELECTRIC PUMPS: YELLOW
- Press button ELECTRIC PUMPS: BLUE
- Press button ENGINE 1: START
- Press button ENGINE 2: START
- Press button HYDRAULIC PUMPS: YELLOW
- Press button HYDRAULIC PUMPS: GREEN

- Click on button 2 in the screen of software to display the pressure in the three hydraulic circuits
- Set the pressure at 3000 psi in each circuit, with the three potentiometers AY2, AG1 and AB3
  Pressure is not sufficient: amber LED on
  Pressure OK: green LED on



The PRESSURE is insufficient in the three circuits

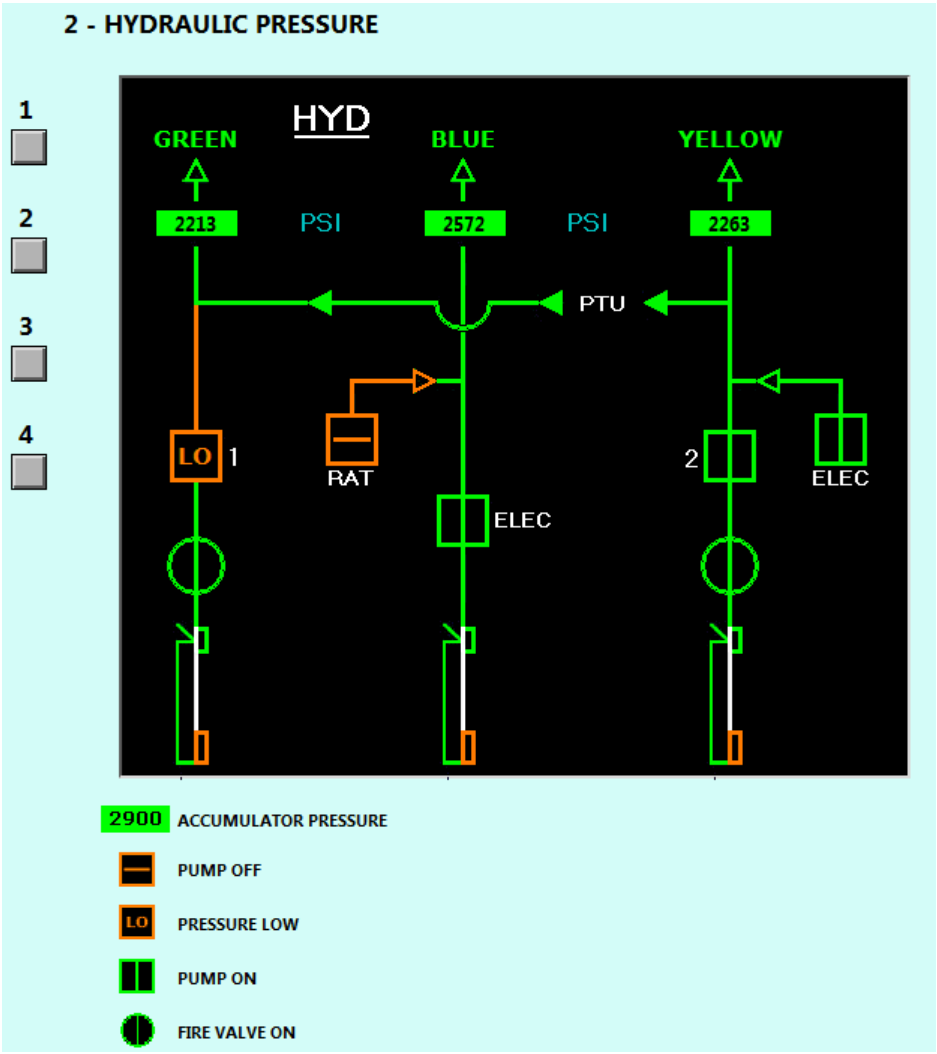


PRESSURE OK in the three circuits

- If pressure is reduced (leakage) in the green or yellow circuit, the PTU (Double pump - Power Transfer Unit) transmits the correct pressure to the other circuit.

- If pump 1 is faulty and consequently the pressure in the green circuit is low, the Power Transfer Unit (PTU) is enabled automatically (green line with arrow) so that a correct pressure is produced in the green circuit

- The same can be told for the yellow circuit



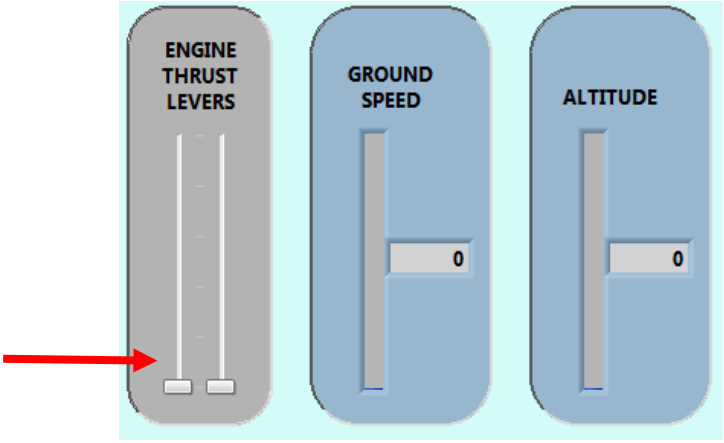
ACTION of PTU

- Pressing button RAT will light the green LED
- The Ram Air Turbine (RAT) is available in the upper left part.
- The RAT will pressurize the blue hydraulic circuit (emergency).

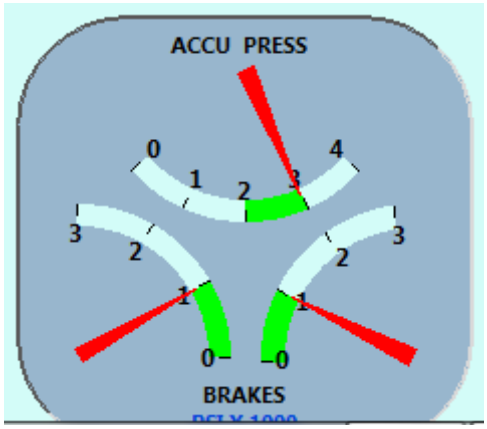
- Select the screen by clicking on button 3
- Refer to the tables of the following parameters:

AQ-2/EV	GROUND	TAKE-OFF	FLIGHT	LANDING
BATT B1 / B2	ON/OFF	ON	OFF	OFF
WHEELS BRAKES	ON/OFF	OFF	OFF	OFF/ON
LANDING GEAR	DOWN	DOWN .. UP	UP	UP .. DOWN
APU	OFF/ON	OFF	OFF	OFF
SLATS	IN	OUT	IN	OUT
FLAPS	IN	OUT	IN	OUT
ENGINES 2 / 1	OFF/ON	ON	ON	ON
SPEED setpoint	0 .. 70	0 .. 1000	0 .. 500	0 .. 500
ALTITUDE	0	<200	>500	>2 .. <300
SPEED BRAKE (SPOILERS)	OFF	OFF	OFF	ON
REVERSE	OFF	OFF	OFF	ON

- Release the park brake: PARK BRAKE = OFF
  - Check the effect of this action on the brakes of the set of wheels (2 red LEDs)
- Move the aircraft on the ground (0 – 70) by acting on lever ENGINE THRUST



- Turning the STEERING wheel will enable to check:
  - the action on the cylinder which shifts the fore directional wheel
  - that the angle of change of direction depends on speed:
    from ± 75 º, at slow speed, down to 0, at 70 km/h



- Press button GROUND BRAKE (pedals of brakes)
- The pressure gauge indicates the braking pressure:
  - 1 x 1000 psi (68 bars)
  - Check that the braking action will put the LEDs on (cylinder of brake); the speed is reduced

- Shifting the ENGINE THRUST LEVER will reduce the speed to 0

- Turn the selector FLAPS/SLATS LEVER to FULL position (total lowering) so that the lift is increased: the LED of TAKEOFF mode starts flashing (after 30 seconds) suggesting to select TAKEOFF mode in order to start the take-off operation.

- Check that the LEDs of cylinders are on in order to lower the (blue coloured) secondary flight surfaces for approximately 30 seconds.

- Check the state of the bar-graphs indicating that SLATS and FLAPS are open.

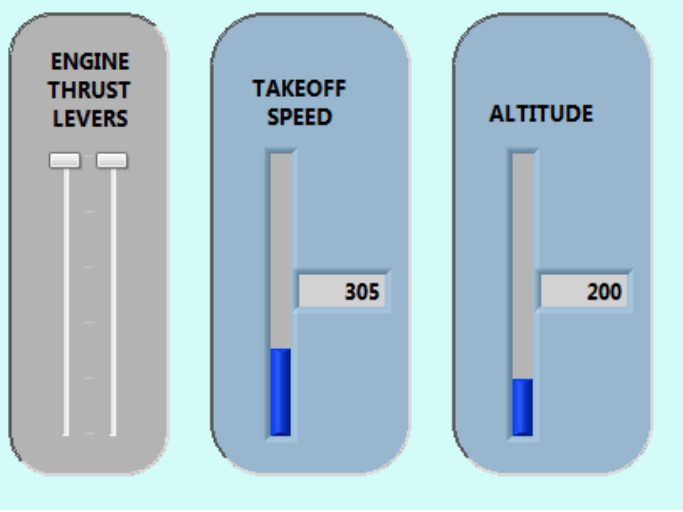
- Turn selector MODE to TAKEOFF position

- Set selector MODE on TAKEOFF position

- Check that selector FLAPS/SLATS is on FULL position

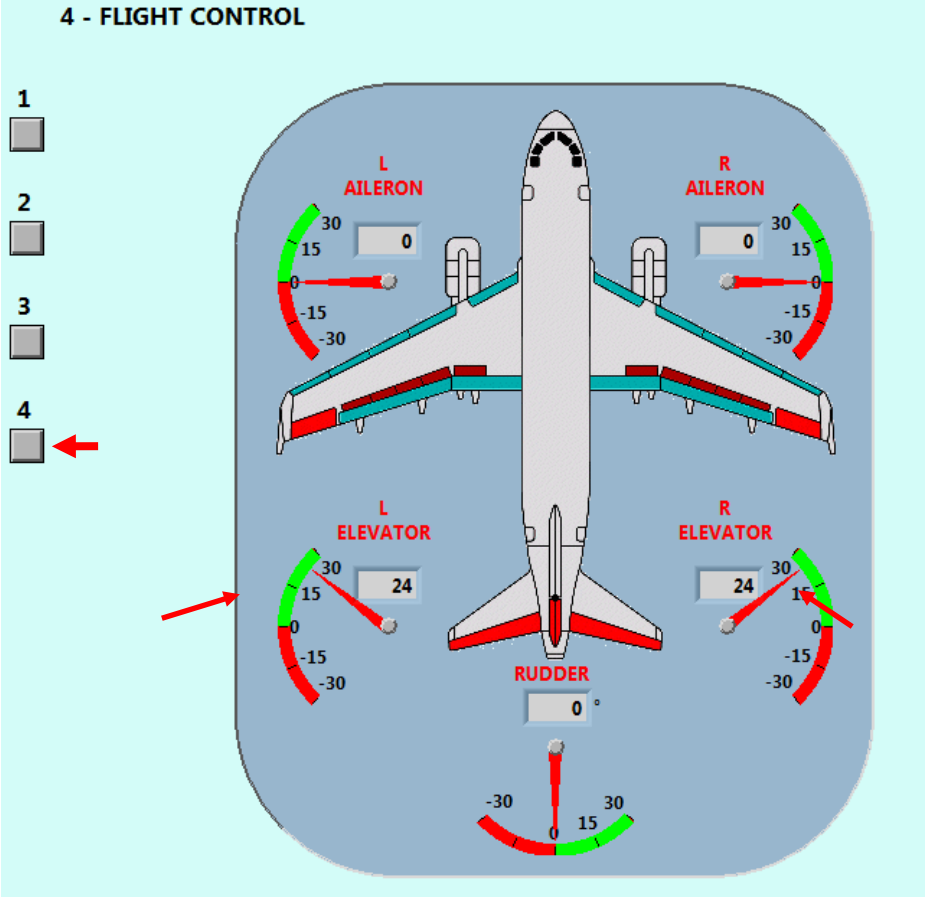
AQ-2/EV	GROUND	TAKE-OFF	FLIGHT	LANDING
BATT B1 / B2	ON/OFF	ON	OFF	OFF
WHEELS BRAKES	ON/OFF	OFF	OFF	OFF/ON
LANDING GEAR	DOWN	DOWN .. UP	UP	UP .. DOWN
APU	OFF/ON	OFF	OFF	OFF
SLATS	IN	OUT	IN	OUT
FLAPS	IN	OUT	IN	OUT
ENGINES 2 / 1	OFF/ON	ON	ON	ON
SPEED setpoint	0 .. 70	0 .. 1000	0 .. 500	0 .. 500
ALTITUDE	0	<200	>500	>2 .. <300
SPEED BRAKE (SPOILERS)	OFF	OFF	OFF	ON
REVERSE	OFF	OFF	OFF	ON

- Shift the ENGINE THRUST LEVER to its maximum position (full power)
- Select
  – PITCH TO TOP (Stick pulled wholly backwards) to lift the aircraft nose,
  in FLIGHT CONTROL SYSTEM
- The aircraft can take off only when speed exceeds 200 km/h

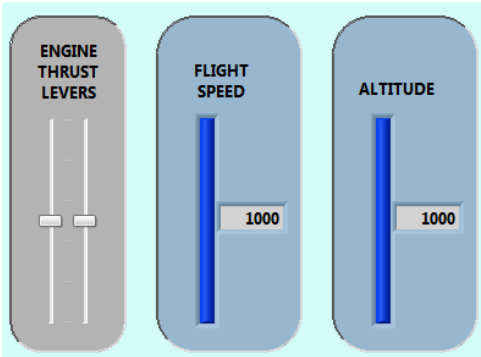


- Speed increases 0 … 1000
- Take-off speed: 200 km/h

- Select the screen by clicking on button 4: the angle of the ELEVATOR is displayed
- Every time the button PITCH TO TOP is pressed, the cylinders controlling the ELEVATOR alternate for safety and for distribution of wear.

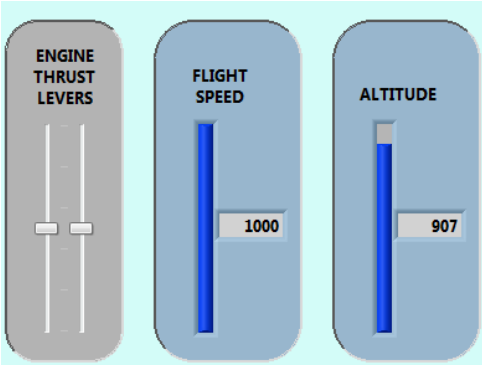


- After the take-off phase, the LED of FLIGHT state starts flashing to indicate the authorization of selecting the FLIGHT MODE.
- Close the SLATS/FLAPS, turn the switch to position 0



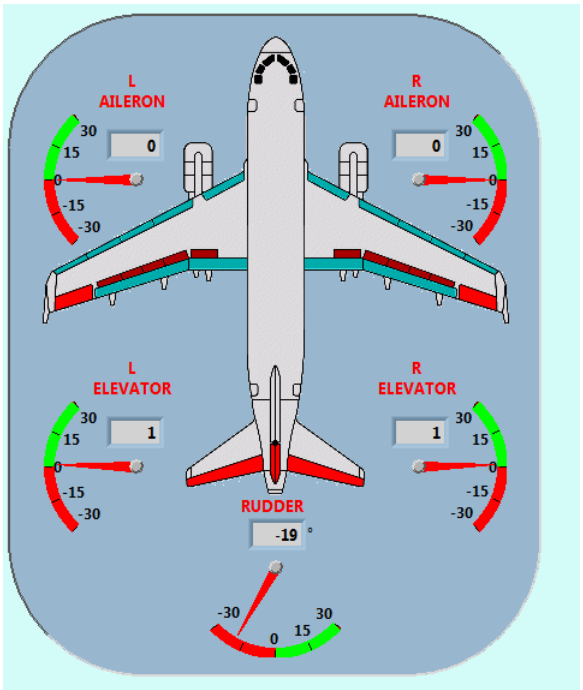
AQ-2/EV	GROUND	TAKE-OFF	FLIGHT	LANDING
BATT B1 / B2	ON/OFF	ON	OFF	OFF
WHEELS BRAKES	ON/OFF	OFF	OFF	OFF/ON
LANDING GEAR	DOWN	DOWN .. UP	UP	UP .. DOWN
APU	OFF/ON	OFF	OFF	OFF
SLATS	IN	OUT	IN	OUT
FLAPS	IN	OUT	IN	OUT
ENGINES 2 / 1	OFF/ON	ON	ON	ON
SPEED setpoint	0 .. 70	0 .. 1000	0 .. 500	0 .. 500
ALTITUDE	0	<200	>500	>2 .. <300
SPEED BRAKE (SPOILERS)	OFF	OFF	OFF	ON
REVERSE	OFF	OFF	OFF	ON

- When selector MODE is positioned on FLIGHT, the three primary (red) flight surfaces can be controlled thanks to the six buttons of the FLIGHT CONTROL SYSTEM panel

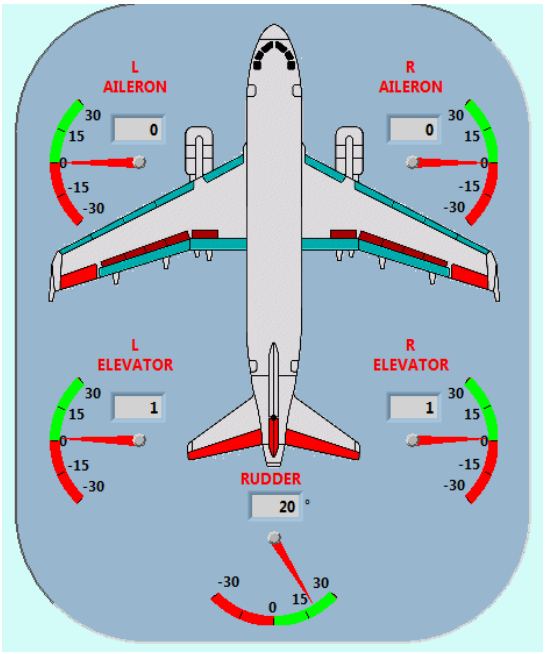


AQ-2/EV	GROUND	TAKE-OFF	FLIGHT	LANDING
BATT B1 / B2	ON/OFF	ON	OFF	OFF
WHEELS BRAKES	ON/OFF	OFF	OFF	OFF/ON
LANDING GEAR	DOWN	DOWN .. UP	UP	UP .. DOWN
APU	OFF/ON	OFF	OFF	OFF
SLATS	IN	OUT	IN	OUT
FLAPS	IN	OUT	IN	OUT
ENGINES 2 / 1	OFF/ON	ON	ON	ON
SPEED setpoint	0 .. 70	0 .. 1000	0 .. 500	0 .. 500
ALTITUDE	0	<200	>500	>2 .. <300
SPEED BRAKE (SPOILERS)	OFF	OFF	OFF	ON
REVERSE	OFF	OFF	OFF	ON

- Shiftment leftwards or rightwards according to the position of the pedals which control the RUDDER position

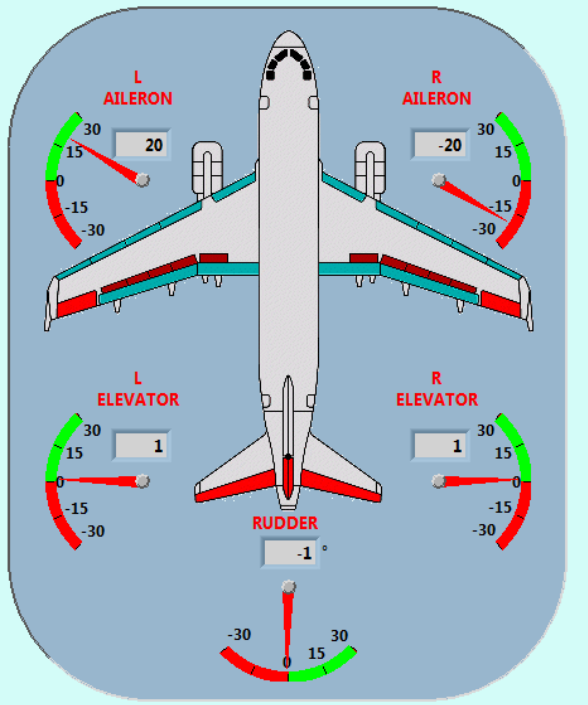


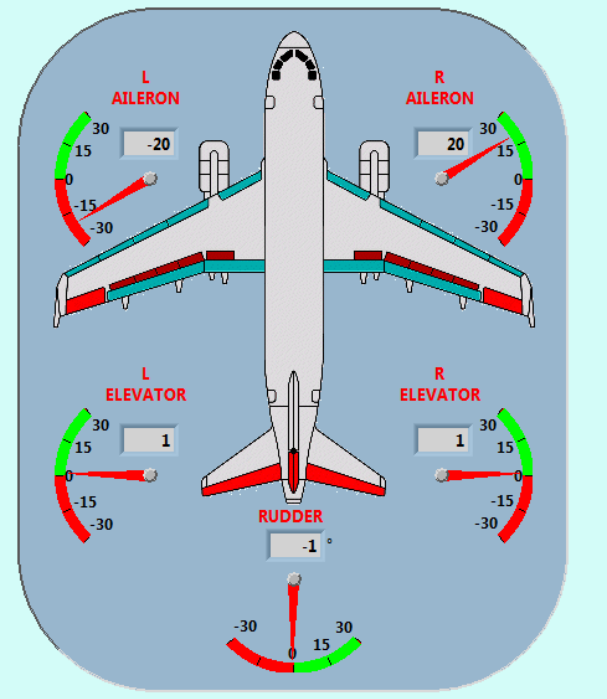
Leftward rotation of the aircraft nose



Rightward rotation of the aircraft nose

- The buttons ROLL L (left) and ROLL R (right) provoke the inclination of the aircraft
- The ailerons are mounted on the outer part of the wings and they move to opposite directions.
- When the pilot shifts the “stick“ leftwards, the left aileron goes up and the right aileron goes down
- When the pilot shifts the “stick“ rightwards, the right aileron goes up and the left aileron goes down



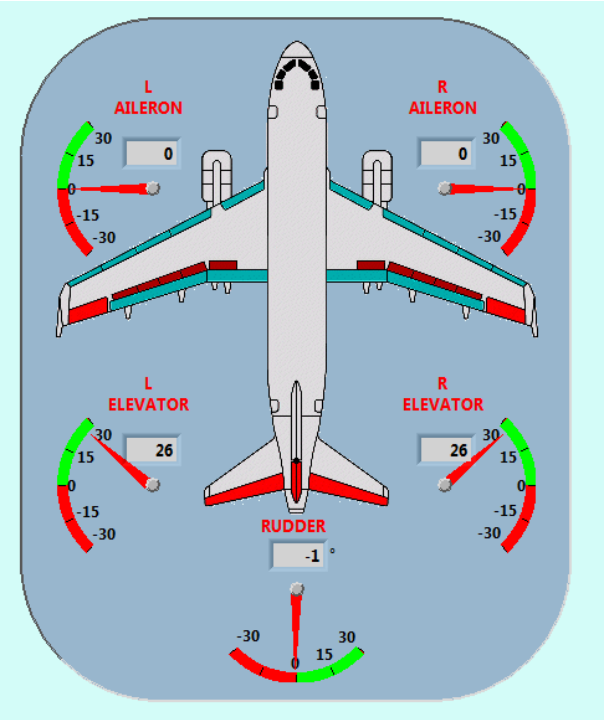


Leftwards inclination
- the left aileron going up reduces the lift
- the right aileron going down increases the lift

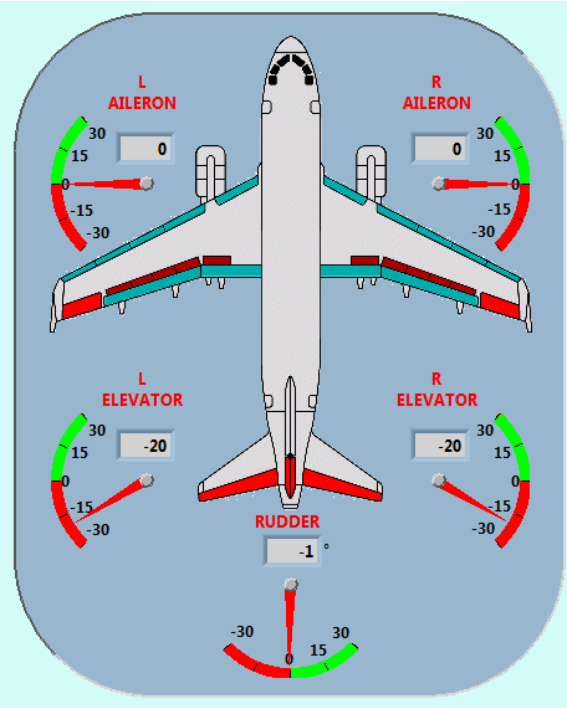
Rightwards inclination
- the right aileron going up reduces the lift
- the left aileron going down increases the lift

.

- The buttons PITCH TO TOP and PITCH TO LOW enable to go up or to go down
- The elevator is a movable surface which can shift upwards or downwards
- When the pilot shifts the “stick” backwards, the elevator and the aircraft nose go up (PITCH TO TOP)
- When the pilot shifts the “stick” forwards, the elevator and the aircraft nose go down (PITCH TO LOW)

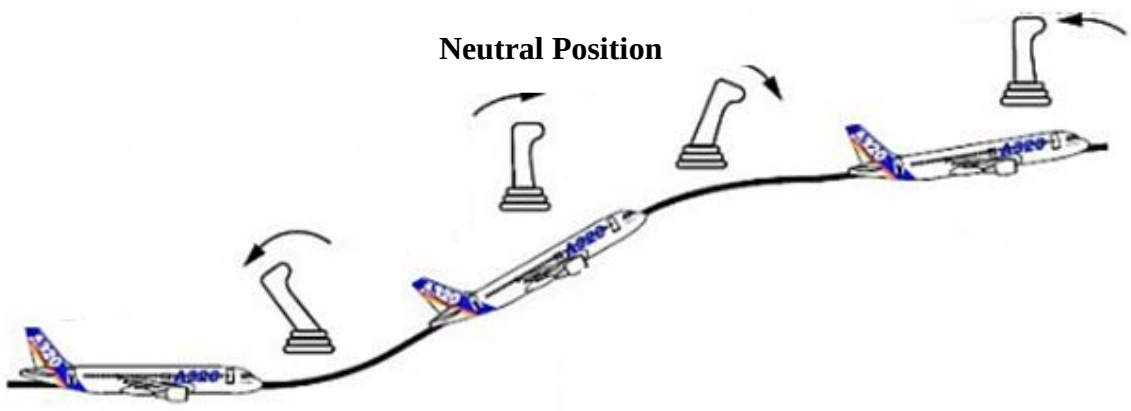


The aircraft goes up



The aircraft goes down

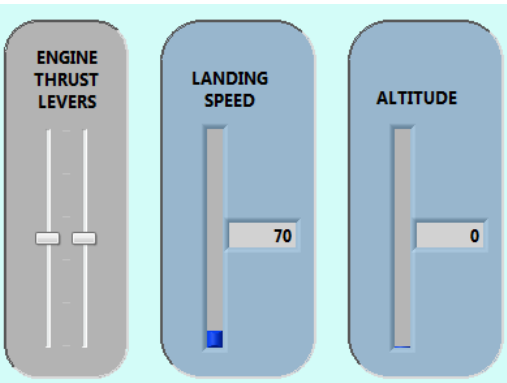
Neutral Position



- With the ELEVATOR on angle 0, the value of altitude is stabilized

LANDING MODE

- Shift the selector of FLAPS/SLATS to FULL
- Shifting the ENGINE THRUST LEVER enables to set the speed allowing the landing
- Reducing speed (< 300) and altitude (<500) will make the LED of ”Landing” mode flash
- Shift selector MODE to LANDING



AQ-2/EV	GROUND	TAKE-OFF	FLIGHT	LANDING
BATT B1 / B2	ON/OFF	ON	OFF	OFF
WHEELS BRAKES	ON/OFF	OFF	OFF	OFF/ON
LANDING GEAR	DOWN	DOWN .. UP	UP	UP .. DOWN
APU	OFF/ON	OFF	OFF	OFF
SLATS	IN	OUT	IN	OUT
FLAPS	IN	OUT	IN	OUT
ENGINES 2 / 1	OFF/ON	ON	ON	ON
SPEED setpoint	0 .. 70	0 .. 1000	0 .. 500	0 .. 500
ALTITUDE	0	<200	>500	>2 .. <300
SPEED BRAKE (SPOILERS)	OFF	OFF	OFF	ON
REVERSE	OFF	OFF	OFF	ON

- Check that the three braking systems are enabled:

  - pressing button SPEED BRAKE will open the spoilers on the wings

  - pressing button REVERSE will enable the cylinders controlling the thrust reverse (braking effect of the air) in the engines

  - pressing button GROUND BRAKE will enable the brakes on the wheels of the landing gear

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