Reference to Figure 43 Flight Controls General Overview

ATA 27 FLIGHT CONTROLS

27-00 FLIGHT CONTROLS GENERAL

SYSTEM DESCRIPTION

Electrical Flight Control System

The EFCS includes two ELACs, three SECs, two FCDCs and four accelerometers.

In normal law angle inputs from the sidestick or commands from the FMGC are calculated in the ELAC to load factor demands for pitch and roll rate demands for roll control and sent to the Servo Sontrol Units (SCU).

In direct law a direct stick to surface relation is provided.

The SECs receive commands from the ELACs to control the spoiler functions. In case of an double ELAC failure the SECs use the sidestick signal and provide a related deflection.

The accelerometers are located in the forward cargo area and are used as feedback for pitch control and load alleviation function.

ELevator Aileron Computer

The two ELAC's provide output to control the elevators, the ailerons and the THS. Feedback from the servo control units (SCU) is returned to the ELACs.
They are made by Thomson/Motorola and consist of two processor units, one being the controlling part the other dedicated to monitor. The two processors will individually calculate the actuator command signal. In case of discrepancy between the COM and the MON channels, output to the actuator will be inhibited.

Spoiler Elevator Computer

Three SECs provide output control to the spoilers and will be back-up for control of the elevators and the THS. The SECs are made by Sextant/Intell and the internal function is similar to the ELAC.

Flight Control Data Concentrator

The FCDCs acquire data from the ELACs and the SECs and transmit the data to the ECAM and the CFDS. The FCDC also provide access to the EFCS for CFDS tests.

Side Stick Controller

Two side stick controllers are used for pitch and roll manual control. Their signal is send via transducer units to the flight control computer.
When both side sticks are moved in the same direction, these signals are added. The sum is limited to single stick maximum deflection.
By depressing a take over pushbutton, the pilot will disconnect the a/p and/or take over priority from the other side stick.

The controller assembly contains a stick lock solenoid to block the stick or disconnect the a/p if the blocking force is overcome. Artificial feel is provided by springs within the assembly.

Servo Control Units

All flight control surfaces are hydraulically actuated. Depending on condition the actuators can be in different modes. On surfaces with two actuators normally only one is active, controlled by one flight control computer. The other SCU remains in damping mode. In case of malfunctions or special conditions both actuators can become active or the control priority can be reconfigured.

Aileron Servo Control Unit

The servo actuator can operate in two different modes:

- Active Mode
- Damping Mode

Spoiler Servo Control Unit

The spoiler actuators can operate in following modes:

- Active Mode
- Biased Mode (control lost but hydraulic available)
- Locked Mode (hydraulic lost)
- Manual Mode (internally deactivated for maintenance)

Elevator Servo Control Unit

The servo actuators can operate in three modes:

- Active Mode
- Damping Mode
- Centering Mode (loss of all four control computers but hydraulic still available)

Rudder Servo Control Unit

Since the Rudder actuators have only mechanical inputs via spring rods they are always operating in parallel in Active Mode if hydraulic power is available and in Damping Mode if hydraulic pressure is lost.

Yaw Damper Actuator

The actuators can operate in two different modes:

- Active Mode
- By-Pass Mode

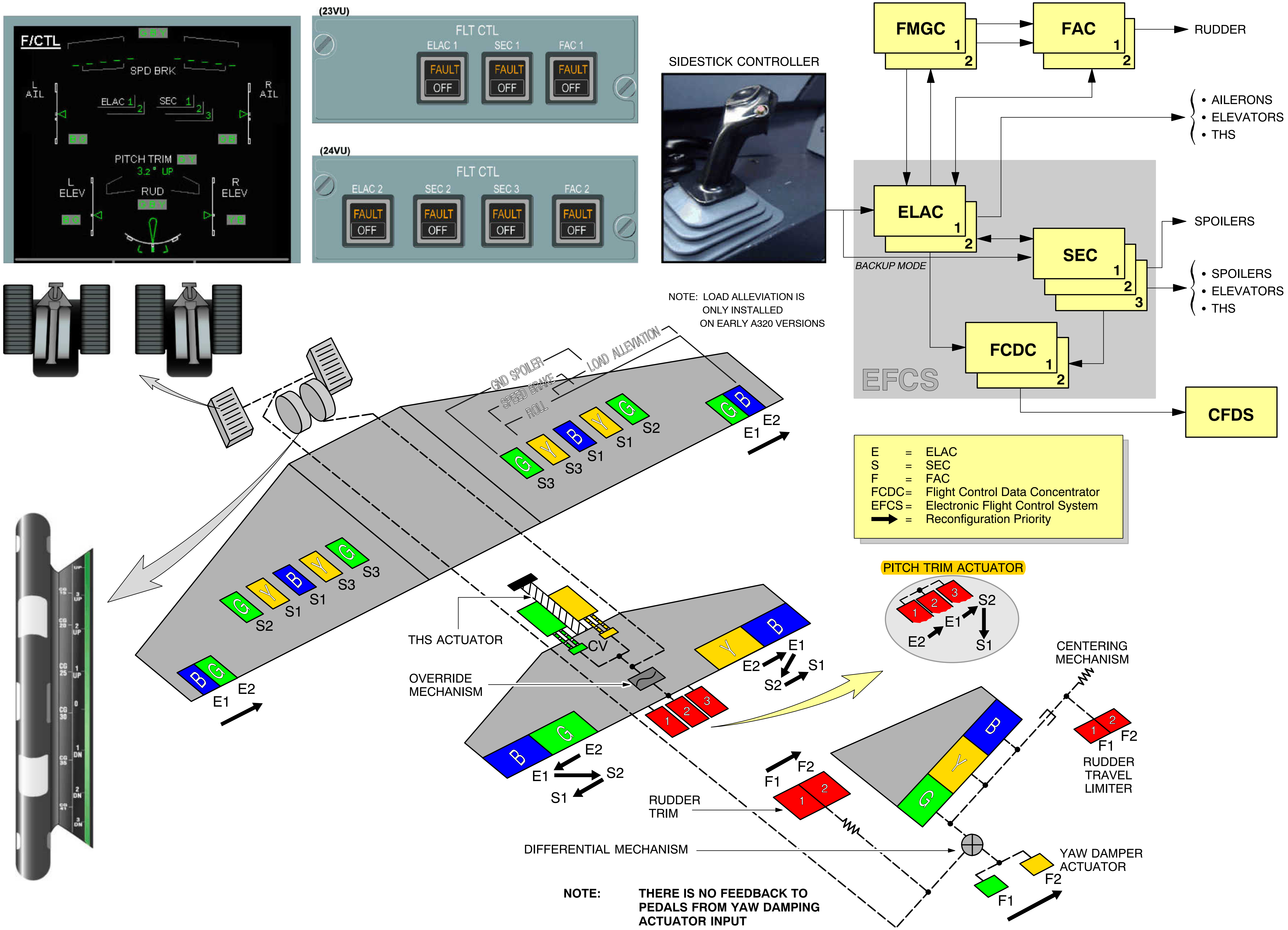


Figure 43 Flight Controls General Overview

Reference to Figure 44 Aileron & Spoiler SCU Modes

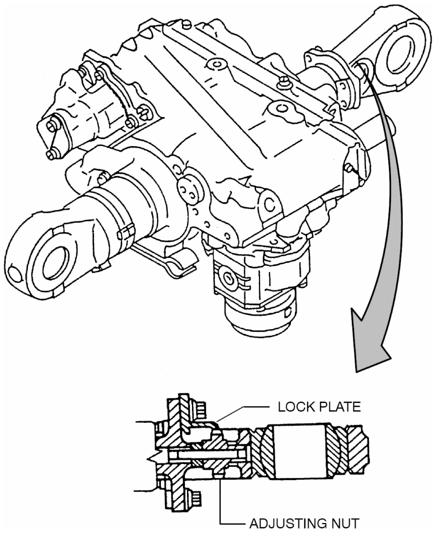
27−10/60 AILERON & SPOILER

SYSTEM OPERATION

Aileron Servo Control Unit

The four units are equal and interchangeable.

The servo actuator is controlled from the ELAC in command. The servo valve, solenoid valve and the mode selector valve are all LRUs. After replacement of the servo valve, adjustment of the feed back transducer is required. An adjustment device is located on the actuator piston end (adjusting nut).



Spoiler Servo Control Unit

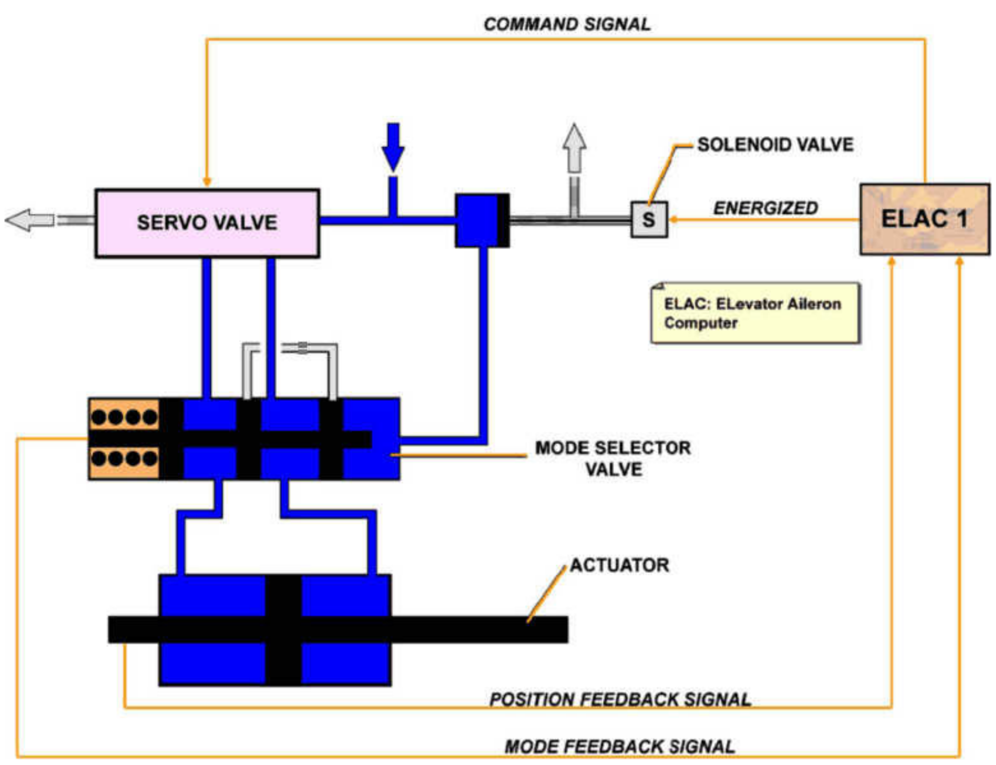
On A320 with LAF (**L**oad **A**lleviation **F**unction) there are two types of servocontrols with different overall dimentions:

- the inboard type for spoilers 1, 2 and 3
- the outboard type for spoilers 4 and 5

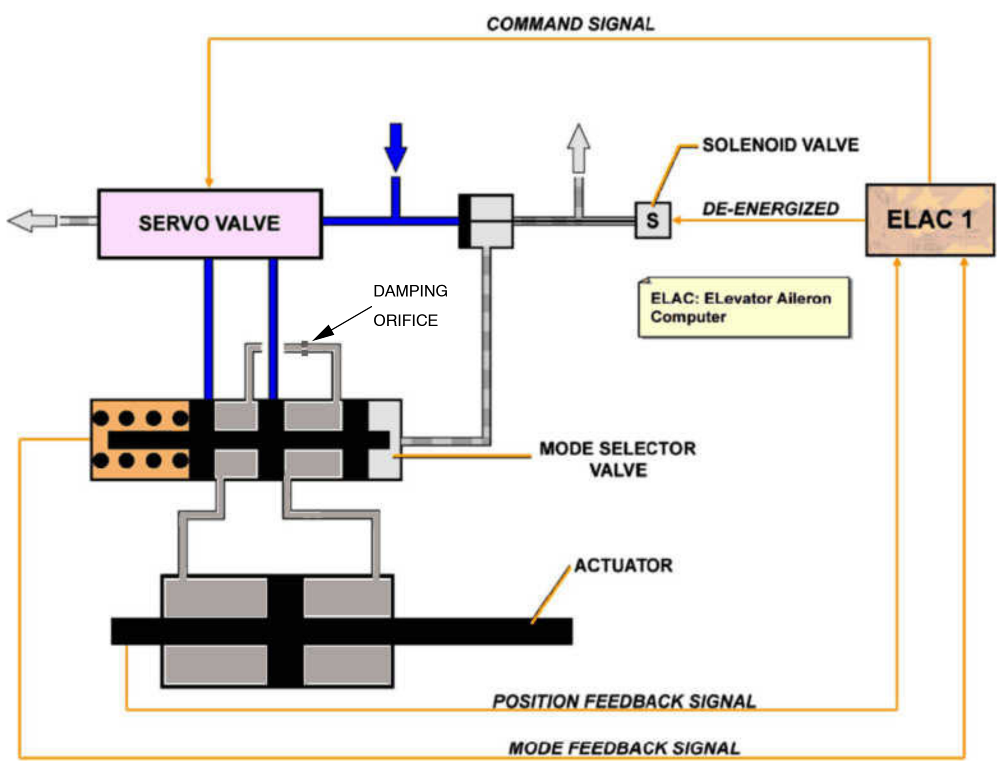
The outboard type is larger than the inboard type because the spoilers 4 and 5 are faster due to their use for the LAF-Function (On A/C without LAF the inboard type is used for all spoiler surfaces).
In Active mode the spoiler actuator is hydraulically supplied and controlled by the SEC.
Biased mode becomes active if the electrical control signal is lost but the servo actuator is still pressurized. The biased servo valve pressurizes the retraction chamber, the actuator stays pressurized and the spoiler panel remains retracted.
Locked mode becomes active if the hydraulic pressure is lost. The closing valve closes the retraction chamber. The spoiler panel can only be moved towards the retracted position, pushed by the aerodynamical forces.
A manual mode is available for maintenance use. The actuator must be depressurized, by turning the maintenance unlocking lever the spoiler panel can be raised for inspection purposes.

AILERON SCU MODES

ACTIVE – SOL ENERGIZED
DAMPING – SOL DE-ENERGIZED



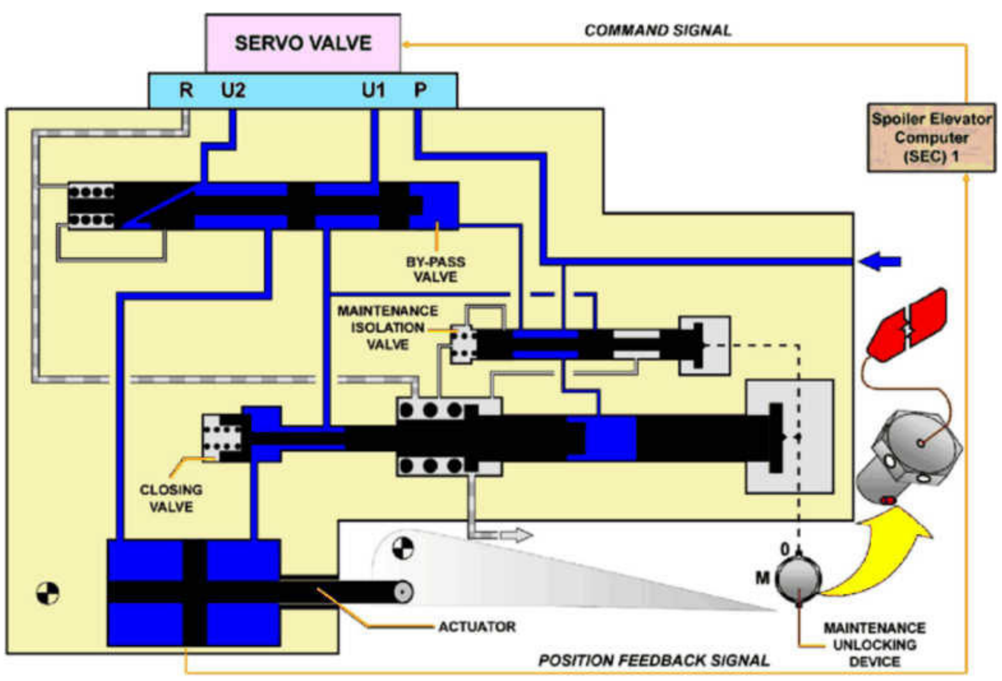
ACTIVE MODE



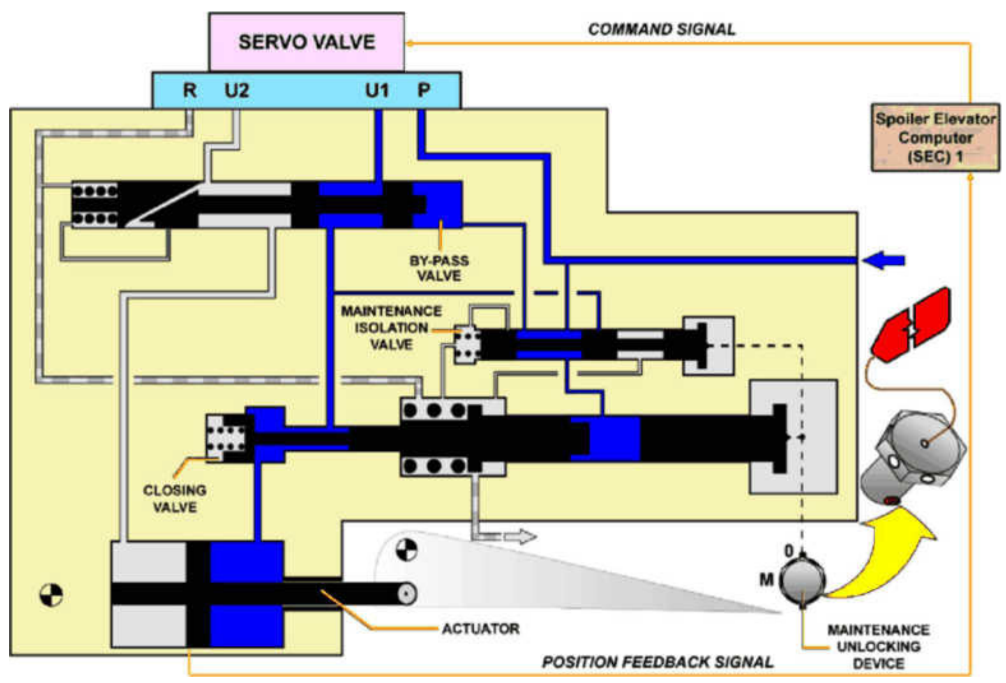
DAMPING MODE

SPOILER SCU MODES

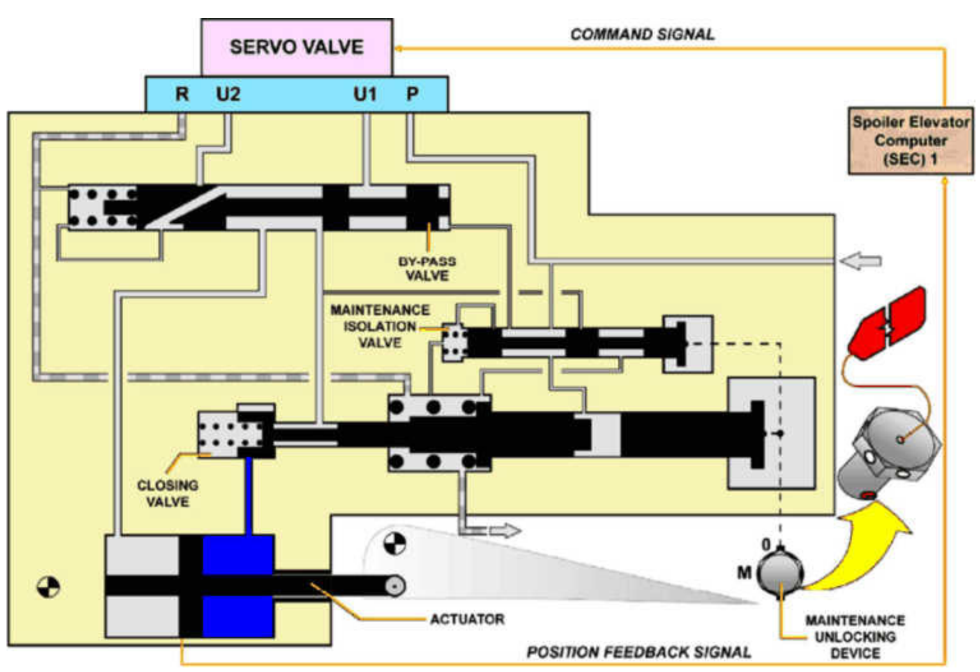
ACTIVE – HYD PRESS AVAIL & ELEC CTL OK
LOCKED – HYD LOST
BIASED – CTL LOST & HYD OK
MANUAL – MAINTENANCE



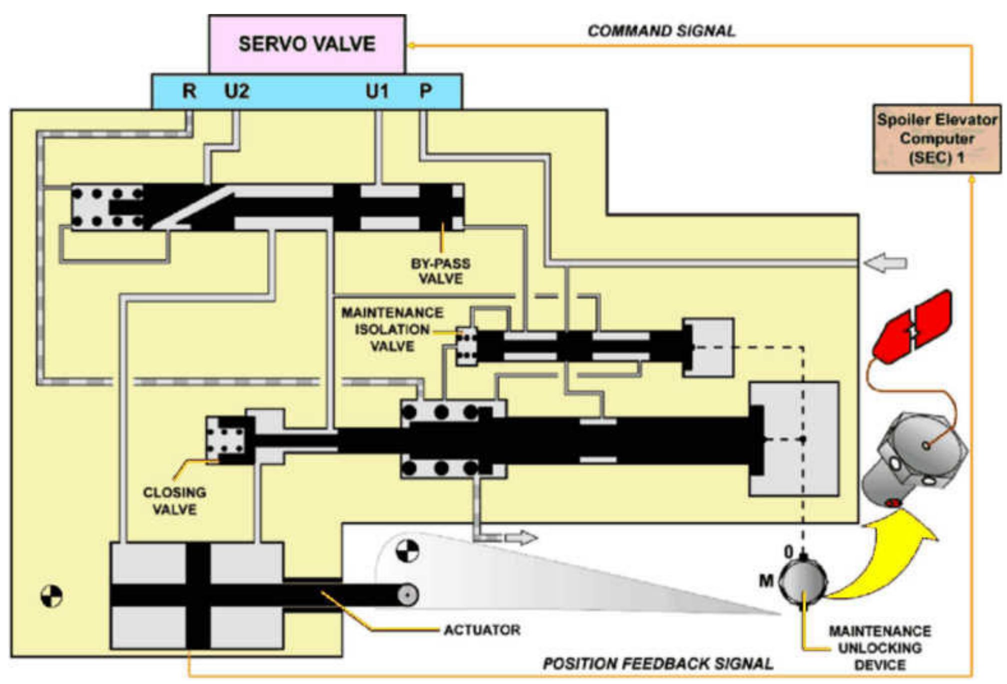
ACTIVE MODE



BIASED MODE



LOCKED MODE



MANUAL MODE

Figure 44 Aileron & Spoiler SCU Modes

Reference to Figure 45

27–40 THS

SYSTEM OPERATION

Trim Wheels and Manual Input

The pitch trim wheel is connected to the stabilizer actuator via a normal cable run. The trim wheel is used to position the stabilizer prior to take off and is also a indicator for stabilizer movement.
If the PTA (**P**itch **T**rim **A**ctuator) controls the THS, the manual command signal causes an override mechanism to brake out and the manual input will go directly to the control valves and thus override the PTA signal.

THS Actuator and Pitch Trim Actuator

The THS is driven by an hydraulic actuator rotating a ball screwjack. The screwjack is equipped with a No-Back Brake of ratchet and pawl type, keeping the ballscrew in the last position, preventing the stabilizer to move by aerodynamic loads.

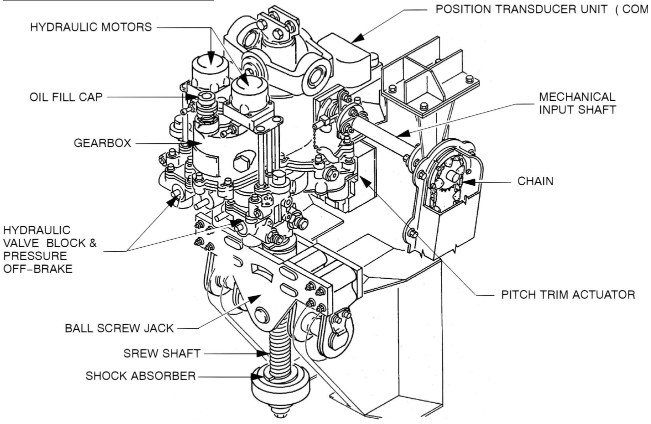
The stabilizer actuator is operated by two hydraulic motors. Each hydraulic motor shaft has a Pressure Off Brake (POB). The POB is a dry brake with a hydraulic release which is used to lock the shaft of the motor if a failure occurs in the hydraulic system or in a hydraulic motor. It thus lets the second motor fully control the ball screw through the power differential.
Input to the two hydraulic motors comes from a Pitch Trim Actuator via a gear train.
The PTA is equipped with three electrical servo motors signalled by the ELACs or the SECs number 1 or 2. One servo motor will be active at any time.

The THS actuator has two inductive position transducer packages. They are the command position transducer and the monitor position transducer. The command position transducer is used to find the position of the override mechanism output/input control sequence to the control system of the THS actuator.

The oil level in the gear box can be checked by a sight glass and refilled via a filler cap. Boroscope plugs in the gear box make inspections possible.

The THS will be in automatic trim mode when the aircraft is airborne, regardless of A/P on or off.
The THS will automatically switch to ground mode, positioning the stabilizer to 0° green range, after touch down plus 5 seconds.
The pilots can override the electrical control via the mechanical control system, through the application of a sufficient force to the control wheels.

THS-ACTUATOR



Elevator Servo Control Unit

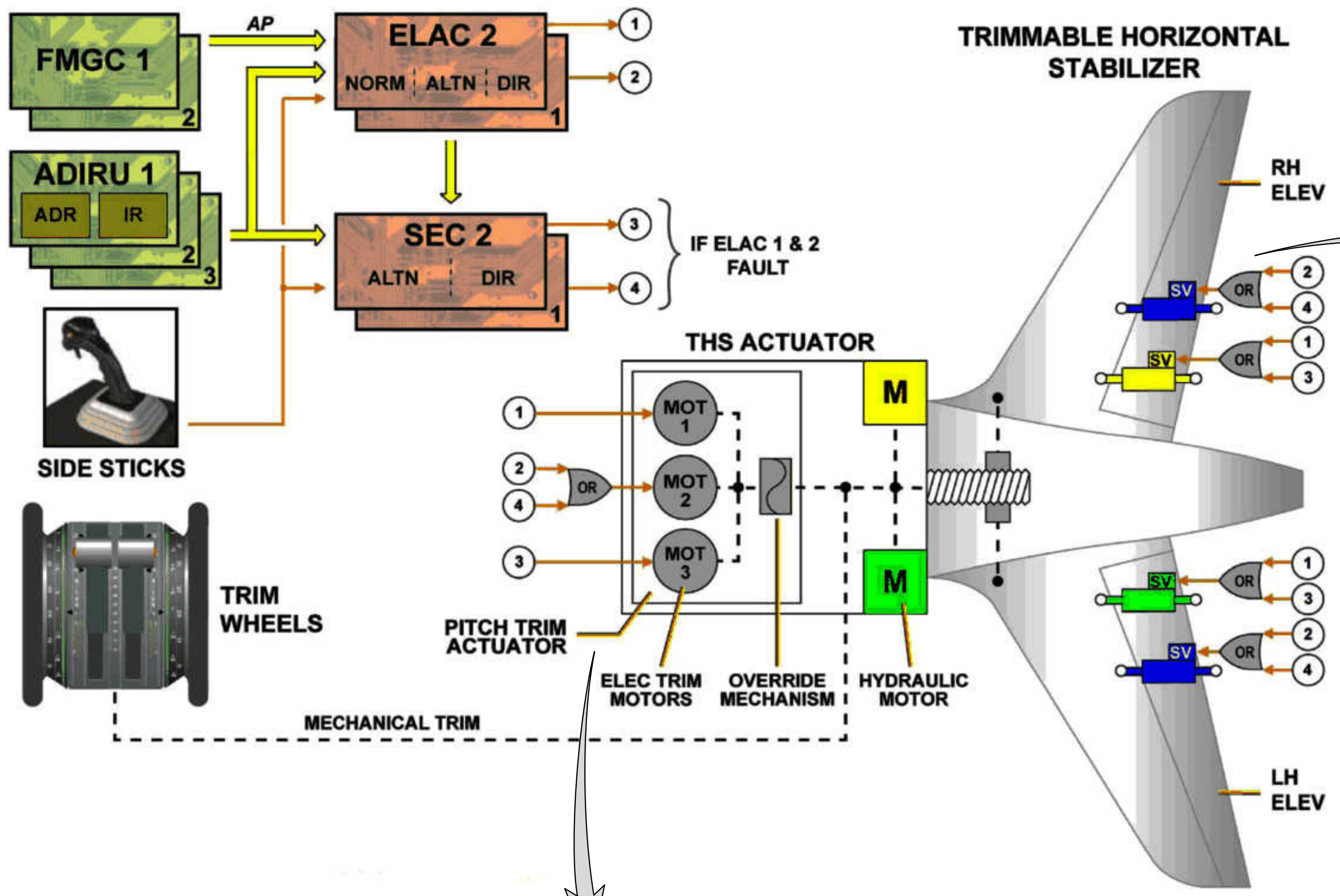
The four fixed body servo actuators are equal and interchangeable. The servo actuators can operate in three modes.
– Active Mode
– Damping Mode
– Centering Mode
In Active Mode the jacks are electrically controlled. In Damping Mode the jacks will follow the surface movement, and in Centering Mode the jack is hydraulically maintained in neutral position.

In the event of high load–factor demand that would cause one servo actuator to stall, the second actuator in damping mode automatically becomes active, both actuators will thus be active.

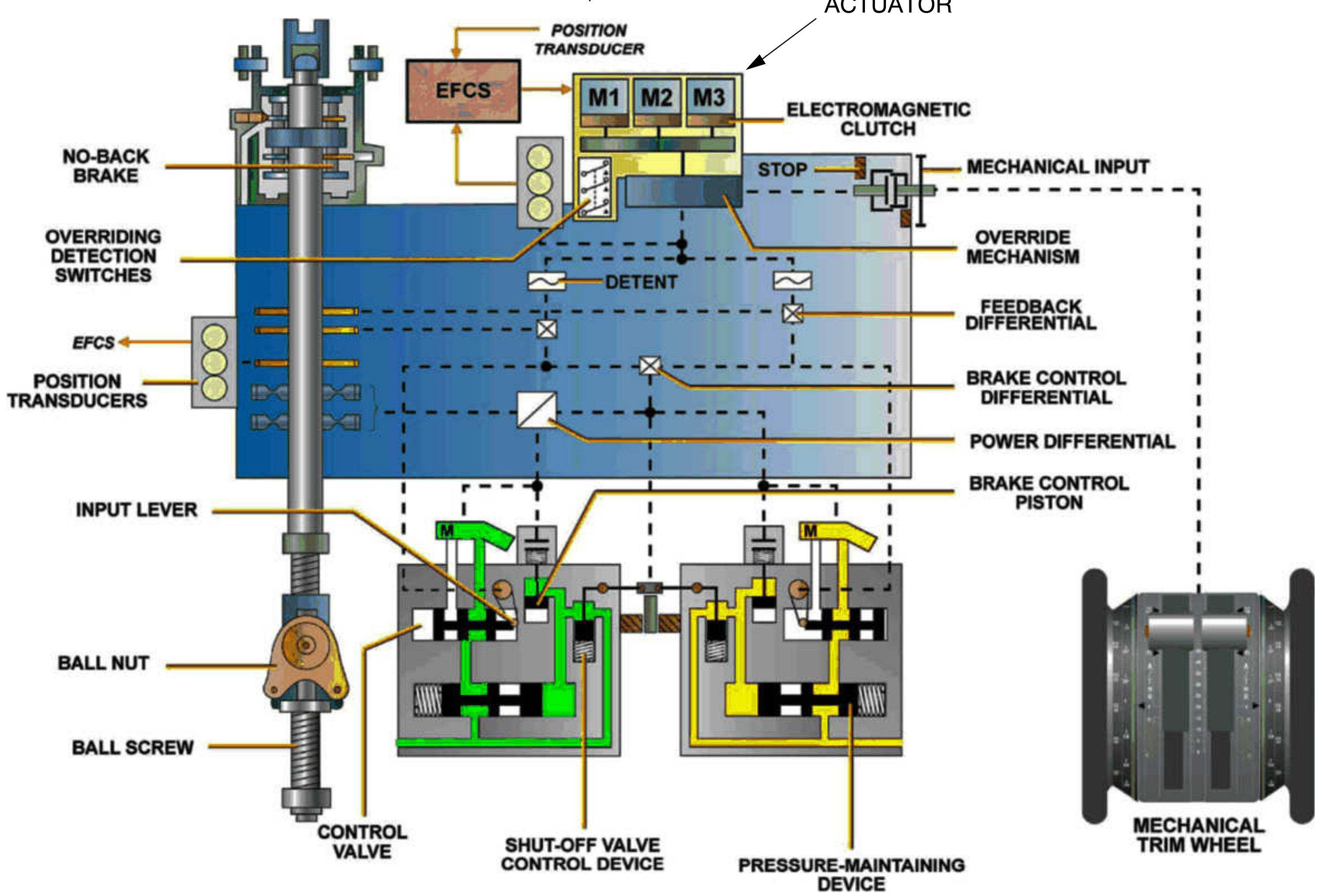
Active Mode means both control solenoid valve are de–energized and internal routing is connecting the actuator to pressure and return.
The High pressure flow will thus activate the mode selector valve.The mode selector LVDT will provide mode feedback to the ELAC and SECs.

Damping Mode means at least one solenoid valves is energized, powered from the stand–by ELAC and SEC.

Centering Mode becomes active in case of loss of control power to all 4 controlling computers and hydraulic pressure still present.
The centering device mechanically(with hydraulic pressure) keeps the actuator in the center position, preventing movement of the surface.
In this case the deflection of the remaining surface is limited in order to prevent excessive asymmetrical load on the tailplane and the rear fuselage.

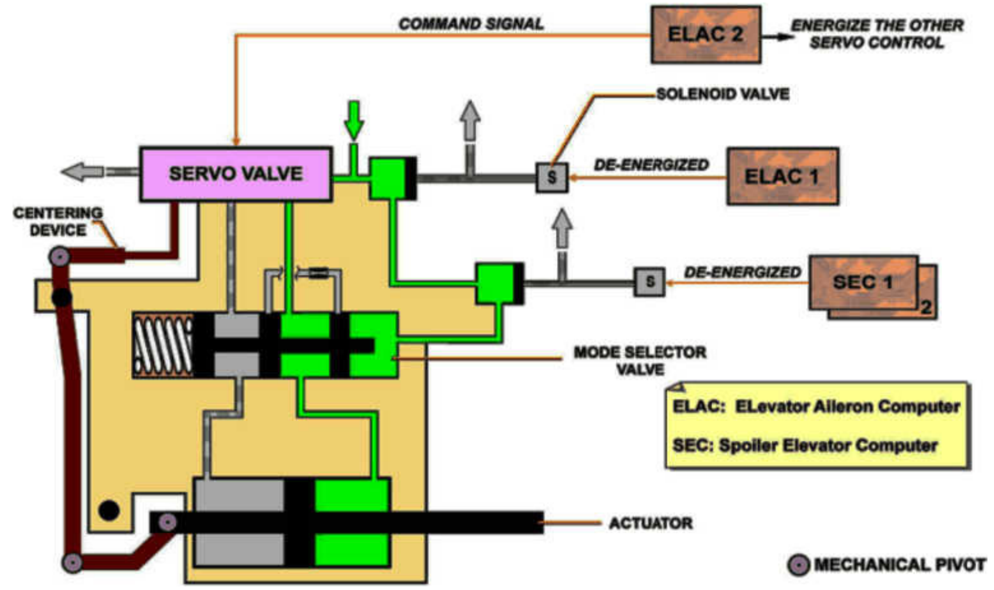


THS ACTUATOR

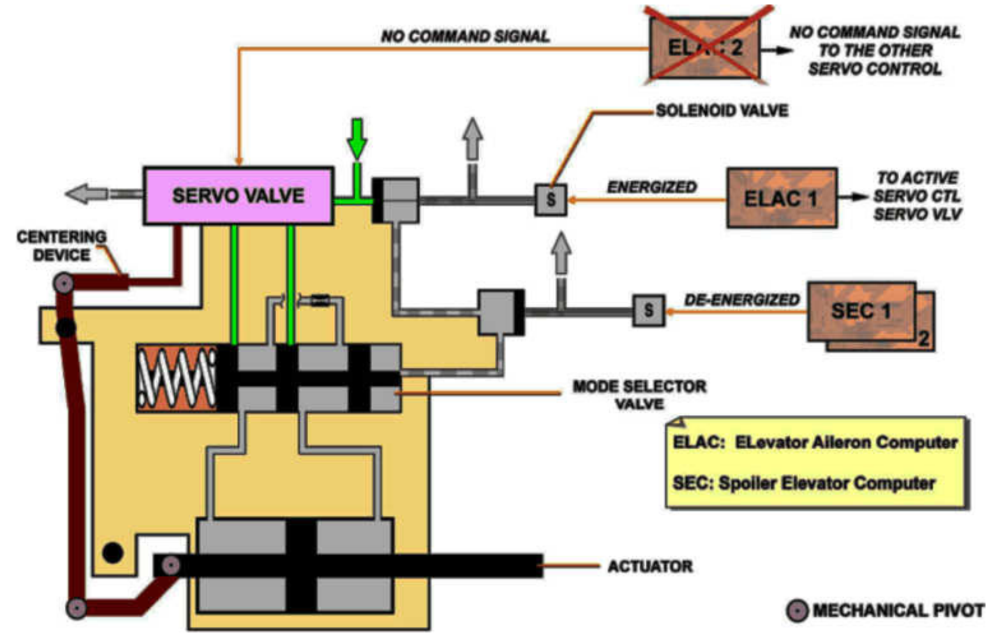


ELEVATOR SCU MODES

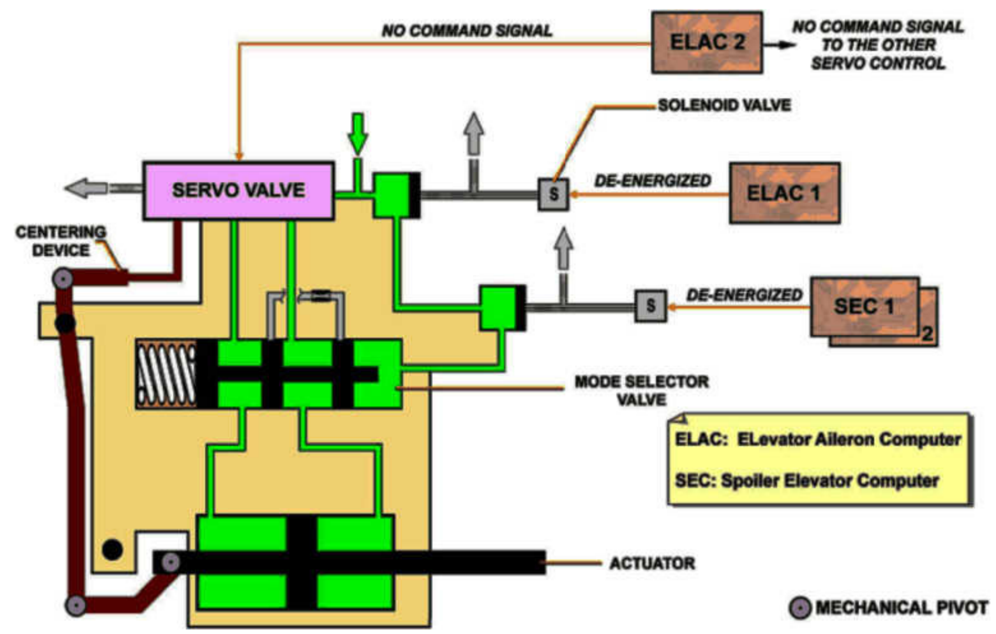
ACTIVE - BOTH SOLENOIDS DE-ENERGIZED
DAMPING - ONE SOLENOID ENERGIZED
CENTERING - LOSS OFF ALL 4 COMP. COMMANDS (HYD STILL AVAIL)
CENTERING DEVICE KEEPS ACTUATOR CENTERED



ACTIVE MODE



DAMPING MODE



RE-CENTERING MODE MODE

Figure 45

Reference to Figure 46 Rudder Control

27−20 RUDDER

SYSTEM OPERATION

Rotary Selector and Reset P/B

The rudder trim rotary selector moves the neutral point of the artificial feel unit at a rate equivalent to 1/sec of rudder deflection. The rudder trim selector is not active when the autopilot is engaged.
By momentarily pressing the reset pushbutton, the rudder trim actuator returns to zero position.
Maximum possible trim input is 20° on A320/321 and 25° on A318/319. This limit is stored in the FAC.

NOTE: The selector and the P/B only electrically adjust the neutral point. This is possible without hydraulic pressure but the rudder surface will not move. If hydraulic pressure is available the rudder surface will follow the neutral point immediately.

Rudder Pedal Transducer

The pedal movement will activate two position transducers connected to ELAC1 and 2. From the ELACs the signal is also transmitted to the BSCU (**B**rake **S**teering **C**ontrol **U**nit), making it possible to steer up to +/− 6°.

Rudder Trim Actuator

The RTA consists of two 3-phase motors installed on the same shaft. They are electrically independent and controlled by electronic modules. The input signals are controlled by the FAC. The actuator mechanism contains mechanical stops but the normal trim limits are controlled and monitored by the FAC.
The RTA is attached to the Artificial Feel & Trim Unit.

Artificial Feel and Trim Unit

The unit consist of a trim screwjack and a constant resting load spring rod. Its purpose is to provide a artificial feel load on the rudder pedals in proportion to the rudder deflection. The system will also take care of centering of the surface to neutral in the absence of control input. When the autopilot activates the rudder trim, the upstream signal to reposition the pedals is provided by the artificial feel unit. The unit also comprises a system which overrides the A/P.
For this function a solenoid is engaged when A/P is selected. The necessary manual input force from the pedals is now increased by ≈2/3. If this resistance is overcome the A/P will be disengaged.

Travel Limitation Unit

The TLU has two electric motors seperately controlled by an FAC via electronic modules. The TLU mechanically limits the rudder deflection depending on A/C speed. Between 160kts and 380kts a variable limitation takes place. Above 380kts only minimum lever output is possible (3.5° rudder deflection). If both FACs fail, the rudder travel limitation value is frozen immediately. In this case, the internal stops return to the low speed configuration when the slats are extended.

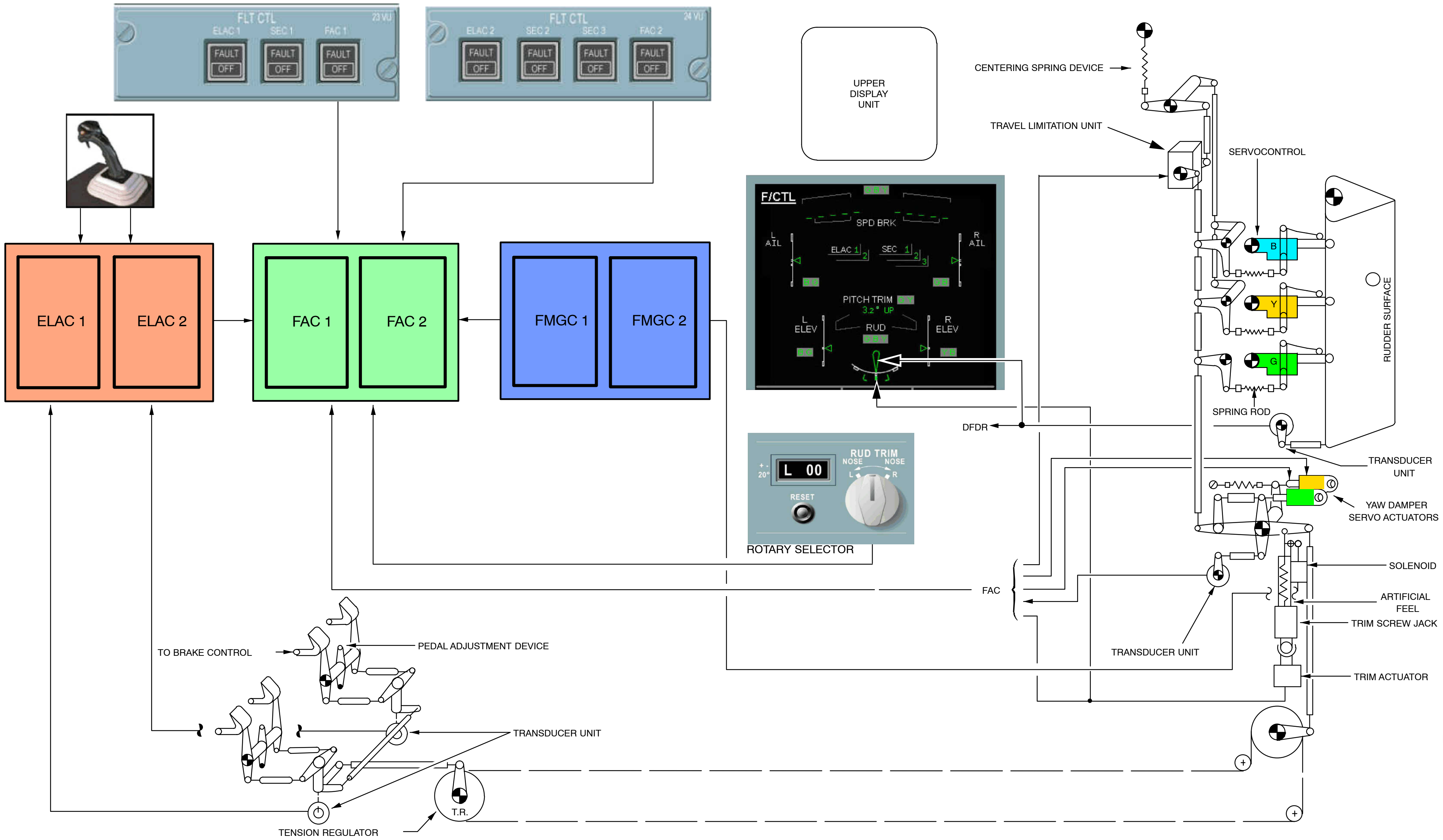
Centering Mechanism

A centering spring device at the end of the input rod will keep the control valves in the center position in case of a broken control rod.

A seperate spring keeps the Yaw Damper Input centered in case of hydraulic failure.

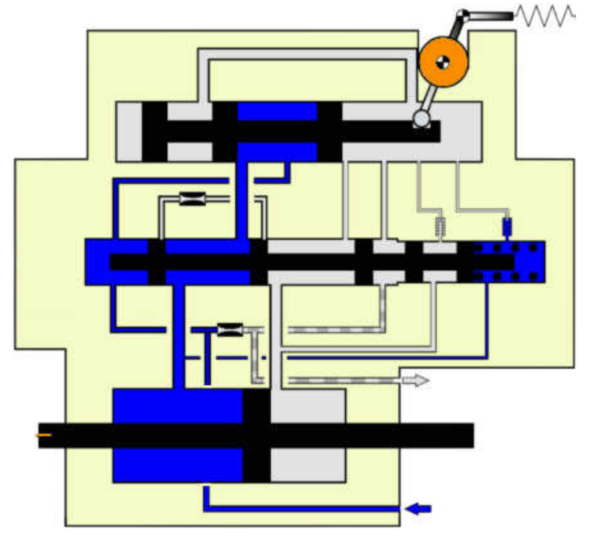
Rudder Position

The rudder position is sensed by a transducer unit signalling the DFDR and the SDAC for position display on the ECAM F/CTL page.
A reverence mark is painted on the rudder and on the reference structure.

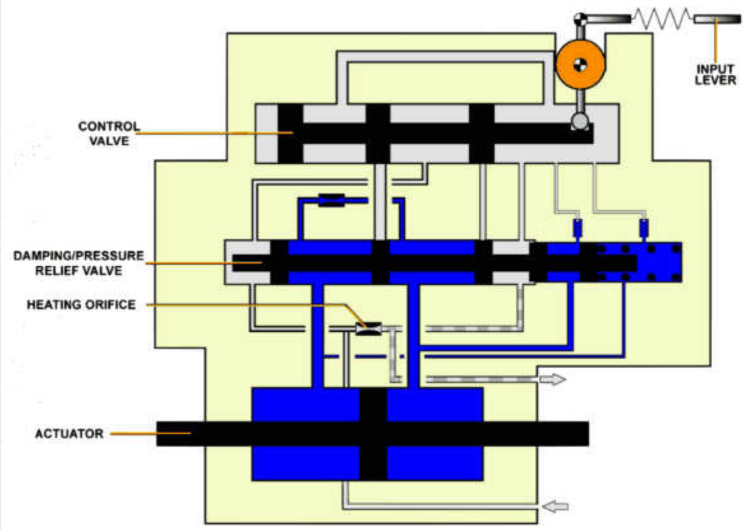


RUDDER SCU MODES

ACTIVE - HYD OK
DAMPING - HYD LOST



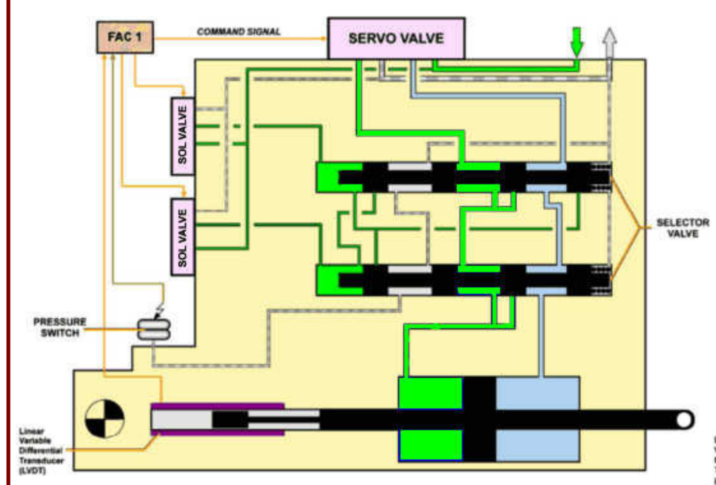
ACTIVE MODE



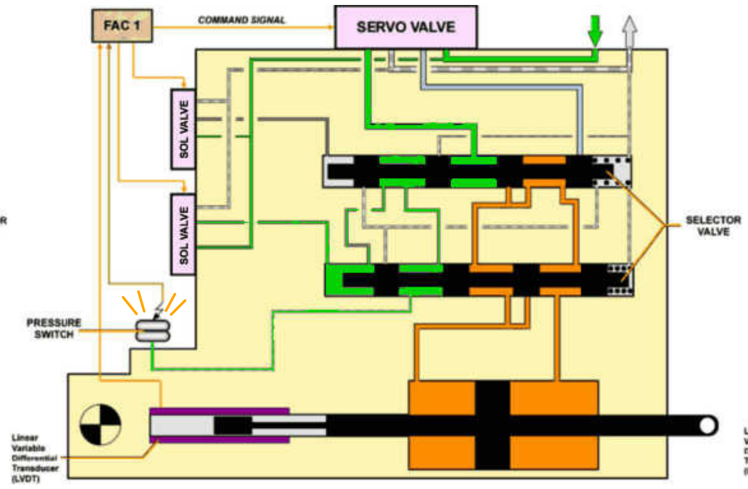
DAMPING MODE

YAW DAMPER SCU MODES

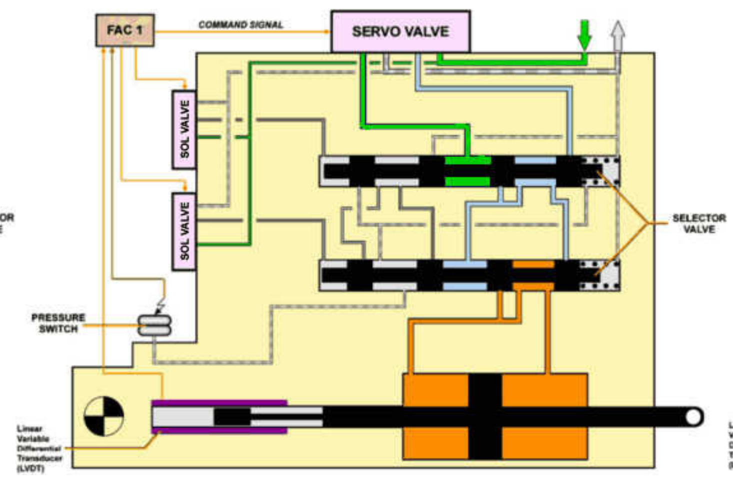
ACTIVE - BOTH SOL ENERGIZED
BYPASS - HYD FAIL OR SOL DE-ENERGIZED
IF ONLY ONE SOL DE-ENERGIZED (ELEC FAIL) PRESS SWITCH WILL BE ACTIVATED FOR FAC INFO



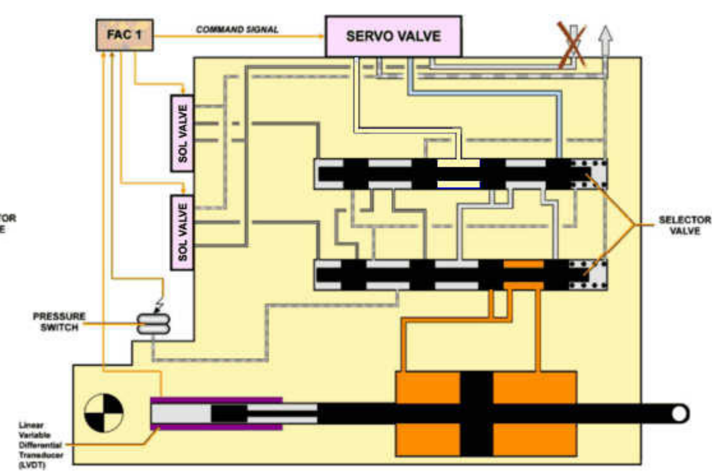
ACTIVE MODE



BYPASS MODE
ONE SOL VALVE DE-ENERGIZED ONLY



BYPASS MODE
BOTH SOL VALVES DE-ENERGIZED



BYPASS MODE
HYDRAULIC FAILURE

Reference to Figure 47 Flaps/Slats System Schematic

27−50/80 FLAPS/SLATS

SYSTEM DESCRIPTION

Slat/Flap Control Computers

SFCC1 and 2 are the same and have two main channels, one for the slats, the other one for the flaps. The computers control, monitor and test the system. In case of a computer failure the connected components can no longer be controlled with respective consequences.

Slat/Flap Control Unit

The unit includes a lever assembly, a five−position gate and a CSU (**C**ommand **S**ensing **U**nit).
The lever position can be changed by pulling a collar on the handle. The CSU sends position signals to SFCC 1 and 2.

Slat and Flap Power Control Unit

A hydromechanical PCU in the fuselage supplies the mechanical power to the flap transmission system. The PCU has two hydraulic motors. Each motor has a POB (**P**ressure-**O**ff **B**rake) and a Valve Block, which is electrically controlled by one SFCC. The main body, which is a case, contains a differential and an intermediate gearbox. Attached to the valve block are three control solenoids. Two Directional Solenoids for extension and retraction. One Enable Solenoid to release the POB. In the PCU Static Mode all three solenoids are de−energized. In the normal Full Speed Mode the SFCC energizes one directional- and the enable solenoid. Short before the intended stop position is reached all three solenoids are energized to slow the system down (Low Speed Mode).

Position Pick-Off Units

A IPPU (**I**nstrumentation **P**osition **P**ick-Off **U**nit) shows the position of the flaps to the FWC (**F**light **W**arning **C**omputer) and is used for ECAM indication. A FPPU (**F**eedback **P**osition **P**ick-Off **U**nit) gives signals of the output shaft position of the PCU to the SFCC. Two APPUs (**A**symmetry **P**osition **P**ick-Off **U**nits) give signals of flap position or speed.
The functions are similar for Slat and Flaps.

Pressure-Off Brakes

The POB has a multiple friction-disk pack which holds the output shaft of the hydraulic motor when:

- the hydraulic motors do not operate
- the related hydraulic system does not supply sufficient hydraulic power
- the WTB stops the flap transmission system because of some system failures

When hydraulic pressure is applied to the POB, the friction disks are disengaged (against the pressure of the springs).

Wing Tip Brakes

Electro-Hydraulic Pressure-On Disk-Brakes, solenoid controlled by the SFCC. When the solenoids are energized, the fluid pressure moves the piston to release the spring force and puts the brake on.
The WTB will be applied in case of:

- Asymmetry (a position difference between the two APPUs)
- Runaway (a position difference between the APPUs and the FPPU)
- Uncommanded Movement (a movement in the wrong direction, or movement away from the last set position)
- Overspeed (the faster movement of one or more PPUs)

Once the WTB is set it can only be reset on the ground through the CFDS or by pulling of especially secured circuit breakers.

Flap InterConnecting Strut

The ICS is attached to the inner and outer flap. It contains two flap attachment failure detection sensors(proximity switches). Via the LGCIU these sensors send data to the SFCC when the independent movement of the inner and outer flaps is more than the specified limit.

Gear Boxes and Torque Limiters

Each shaft system includes various types of gearboxes. Bevel Gear Boxes and a T−Gear Boxes transmit movement into different angles. Input and Offset Gear Boxes transmit movement to the Slat Drive Actuators and the Flap Rotary Actuators.
Input and Offset Gearbox housings contain Torque Limiters to stop the transmission of too much torque into the output shaft. These Torque Limiters can be reset by operating the system in the opposite direction and have spring loaded indicators to show that the limiter has been activated. The indicator stays extended until it is reset manually.

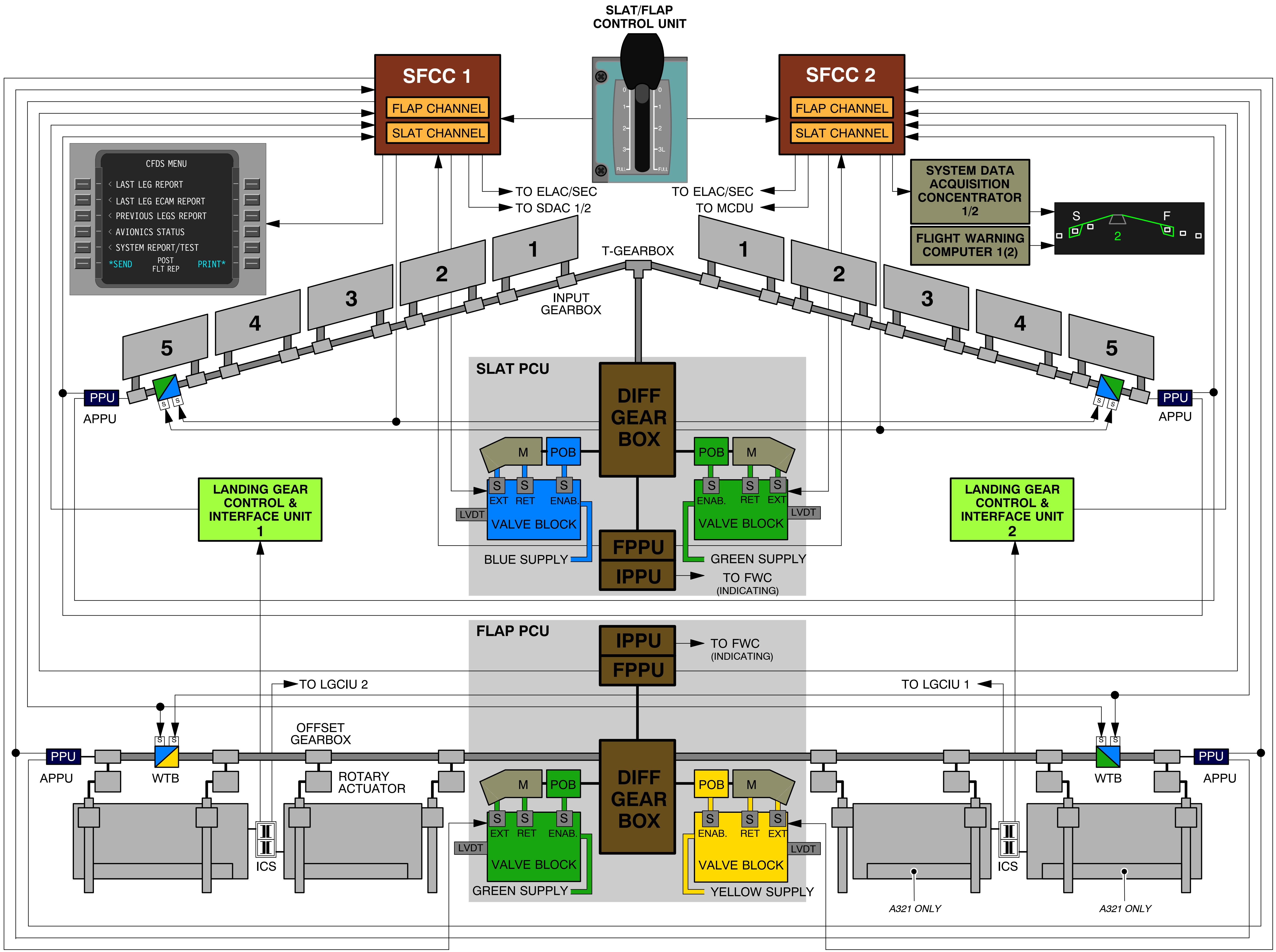


Figure 47 Flaps/Slats System Schematic