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Airbus
A318/A319/A320/A321

ATA 27
Flight Controls

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ATA 27 FLIGHT CONTROLS

27-00 GENERAL

SURFACES INTRODUCTION

Primary Flight Controls

The primary flight control surfaces perform the Roll, Pitch and Yaw control.

Roll Control

Roll control is achieved by an aileron and four roll spoilers on each wing.

They are electrically controlled and hydraulically powered.

Pitch Control

Pitch control is achieved by two elevators hinged on the trimmable horizontal stabilizer. They are electrically controlled and hydraulically powered.

The THS is hydraulically operated and controlled electrically or manually by a cable run from the pitch trim wheel on the pedestal to the hydraulic control valve on the THS actuator.

Yaw Control

Yaw control is provided by a single surface rudder.

It is electrically or mechanically controlled and hydraulically powered.

LAF (Load Alleviation Function on A320)

Wing gust load alleviation is achieved by deflection of the ailerons and spoilers 4 & 5 and is computed by the EFCS (**E**lectrical **F**light **C**ontrols **S**ystem) computers.

This function is installed on the first A320 versions only.

Speed Brakes

Speed brake control is achieved by the spoilers 2 to 4 on each wing.

They are electrically controlled and hydraulically powered.

Secondary Flight Controls

The secondary flight controls consist of flaps, slats and the ground spoiler system.

Ground Spoilers

Lift dumping is achieved by all 5 spoilers on each wing. They are used to reduce the lift on the wing in the landing phase or during aborted take−off.

Flaps

The flaps provide lift augmentation during take−off and landing. The flaps are divided in two sections on each wing and are electrically controlled and hydraulically operated.

Slats

The slats system also provides lift augmentation during take−off and landing. The slats system consist of five sections on each wing leading edge. The control and operation is similar to the flaps.

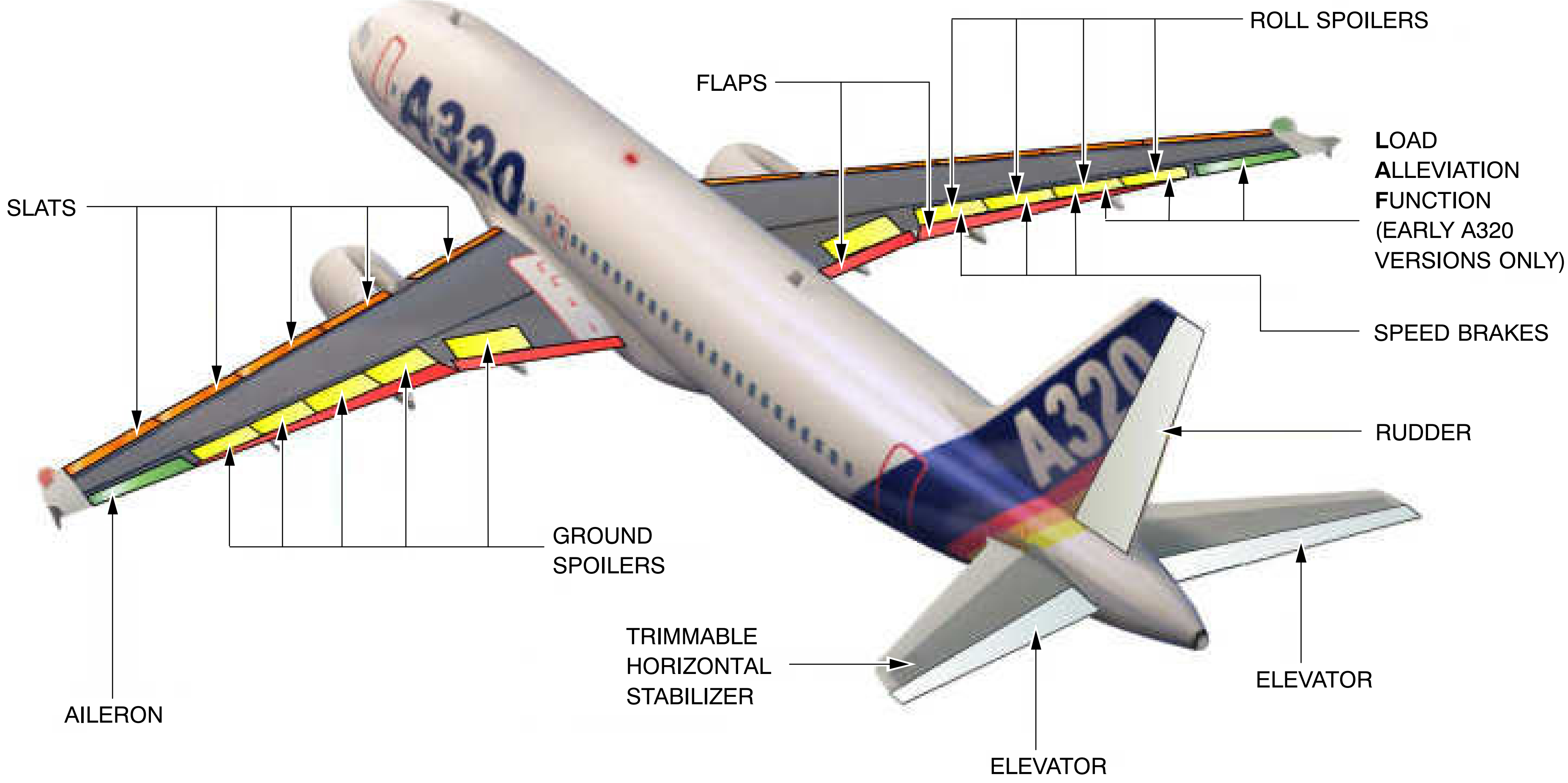


Figure 1 Control Surfaces

FLY BY WIRE PHILOSOPHY INTRODUCTION

General

All the flight control surfaces are now electrically controlled and hydraulically operated. In addition, the stabilizer and the rudder have hydromechanical control back-up in case of electrical failure.

The main advantages of this philosophy are an improvement in redundancy, in handling qualities and thus in performances

The pilots inputs are interpreted by the computers and move the flight controls as necessary to achieve the desired flight path.

However regardless of the pilot's inputs the computer will prevent:

- excessive manoeuvres
- exceedance of the safe flight envelope.

Control Column

The control column has been replaced by the side stick.

Mechanical Linkage

The mechanical channel is replaced by electrical wiring and computers.

These computers control the servo-actuators.

The computers elaborate the flight control laws, including flight envelope protection, which optimize the control of the aircraft

Autopilot Servo

The autopilot commands are directly transmitted to the computers.

Artificial Feel

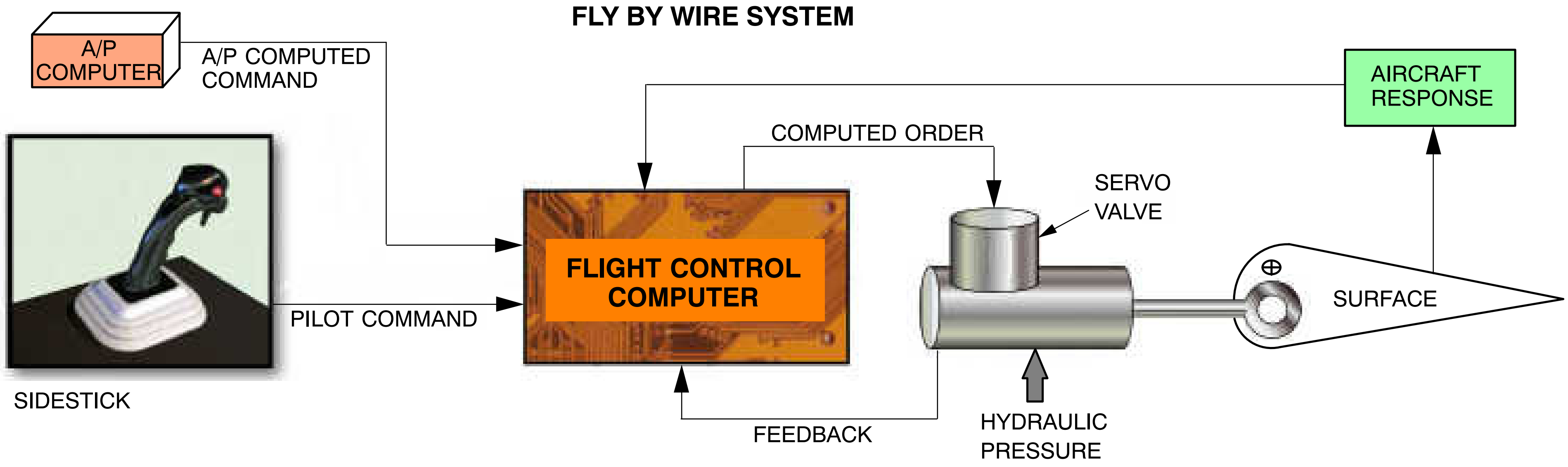
The modulated artificial feel is replaced by the side stick centering spring.

Servo Actuator

The mechanical feedback of the conventional servo actuator is replaced by an electrical feedback to the computers.

Control Wheel Steering Function

The CWS (**C**ontrol **W**heel **S**teering) function is ensured by the computers which use the aircraft response to maintain the required attitude.



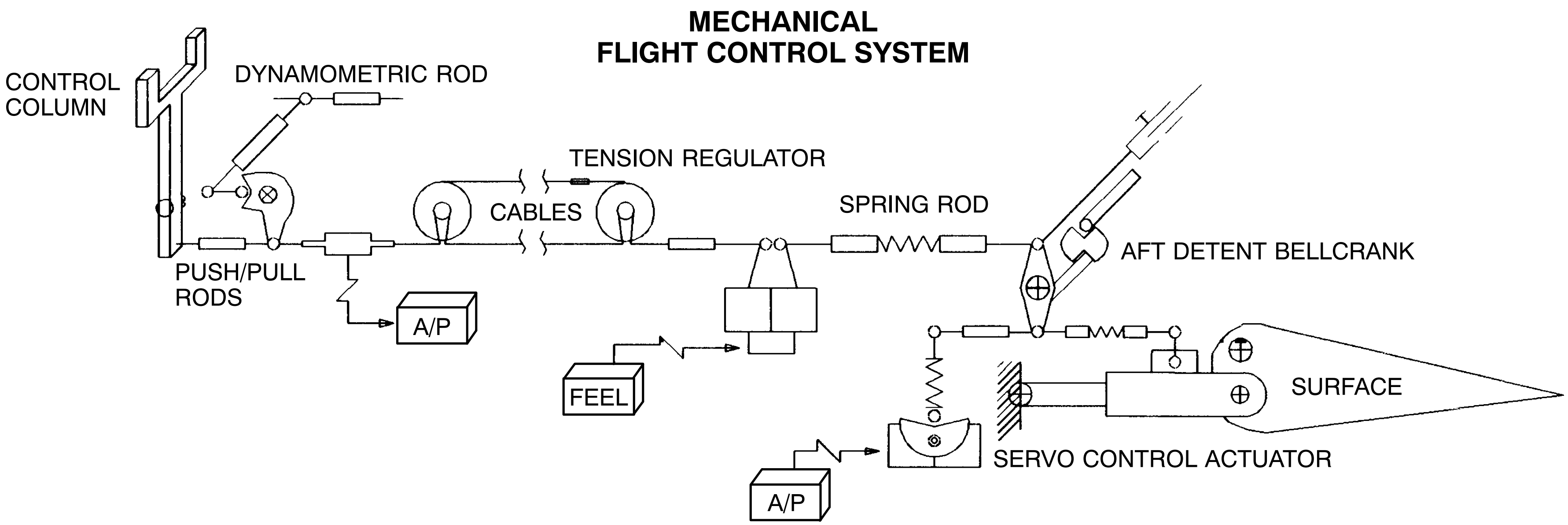


Figure 2 Fly By Wire Philosophy

ELECTRICAL FLIGHT CONTROL SYSTEM (EFCS) INTRODUCTION

Flight Controls Computers

The flight control computers process pilot and A/P inputs according to normal, alternate or direct flight control laws.

All surfaces are electrically controlled through a computer arrangement which includes:

2 ELACs (**El**evator **A**ileron **C**omputer)

Providing: Normal elevator and stabilizer control. Aileron control.

3 SECs (**S**poilers **E**levator **C**omputer)

Providing: Spoilers control. Standby elevator and stabilizer control.

2 FACs (**F**light **A**ugmentation **C**omputer)

Providing: Electrical rudder control.

2 SFCCs (**S**lat/**F**lap **C**ontrol **C**omputer)

Providing: Electrical slat/flap control. Slat/flap data to other systems.

2 FCDCs (**F**light **C**ontrol **D**ata **C**oncentrators)

Acquire data from the ELAC‘s and SEC‘s and send this data to EIS and CFDS.

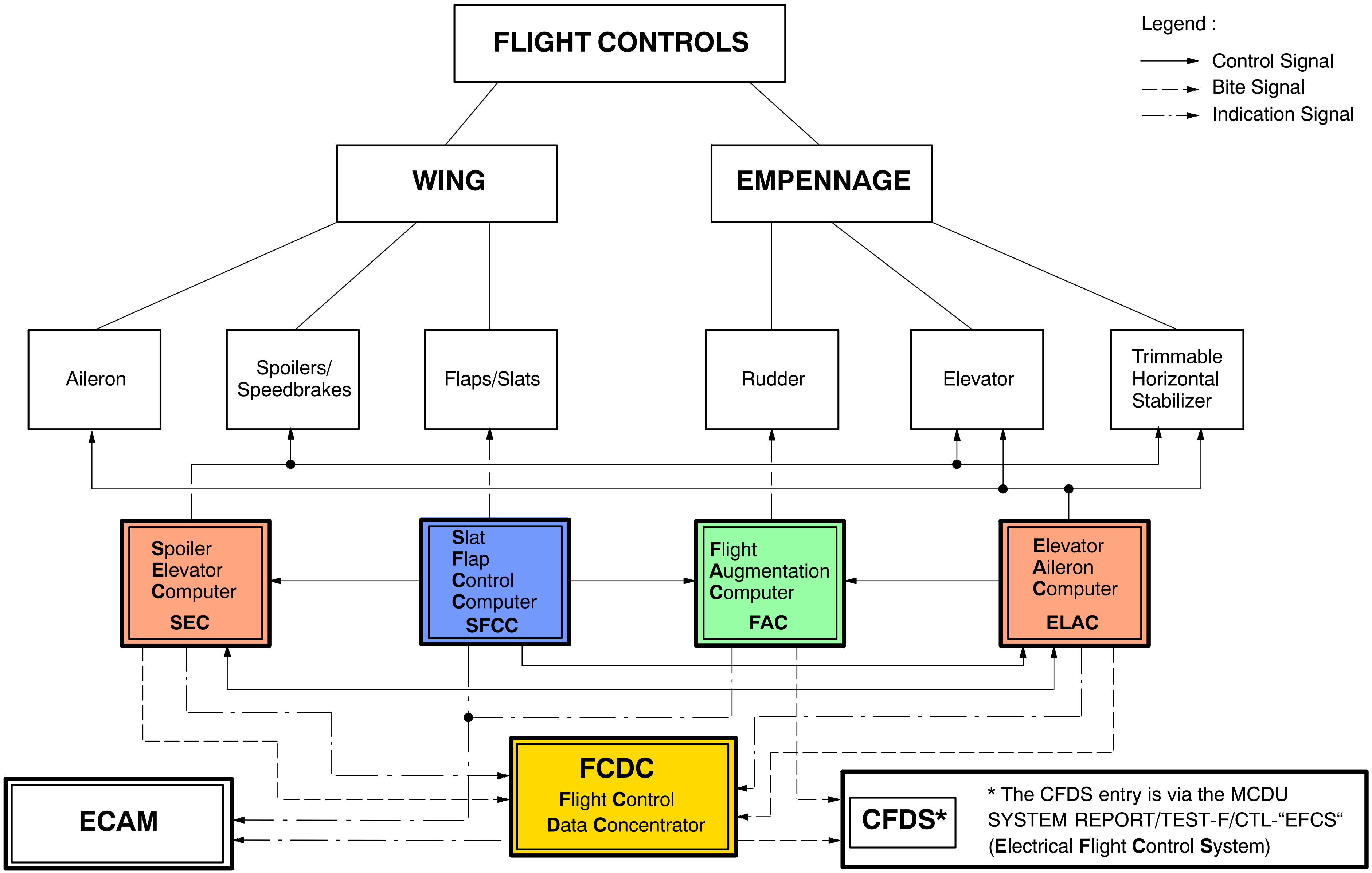


Figure 3 Flight Control Computers

ELECTRICAL FLIGHT CONTROL SYSTEM (EFCS) INTERFACES

The EFCS (**E**lectrical **F**light **C**ontrol **S**ystem) includes the two ELACs, the three SECs, two FCDCs (**F**light **C**ontrol **D**ata **C**oncentrators) and four accelerometers.

The two ELACs are made by Thomson (Motorola). Internally they 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.

The ELACs provide output to control the Elevators, the Ailerons and the THS. Feedback from the surface actuator are returned to the ELACs.

The three SECs are made by Sextant (Intel). Internally they also consist of one COM and one MON processor. The SECs provide output control to the Spoilers and will be back-up for control of the Elevators and the THS. The SECs will also receive position feedback from the control surfaces.

The FCDCs (**F**light **C**ontrol **D**ata **C**oncentrators) acquire data from the ELACs and the SECs and transmit this to the ECAM and the CFDS. The FCDC also provide access to the EFCS for CFDS tests.

The accelerometers are used for the pitch control law and the detection of LAF.

Automatic "power-up" and "pressure-up" tests of the EFCS are performed without any surface movement.

The wire runs from the computers to the surface actuators are located under the cabin floor beams left and right side and under the cabin ceiling.

In the wings, Aileron signals are routed in the leading edge and Spoiler signal in the trailing edge.

The A318/319/320/321 will operate in "NORMAL LAW" with all projections active, when EFCS are normal and electrical power and hydraulic pressure is available.

The aircraft can operate in a downgraded configuration called "ALTERNATE LAW" with or without protections or "DIRECT LAW" in case of malfunctions or loss of more than one hydraulic or electrical system.

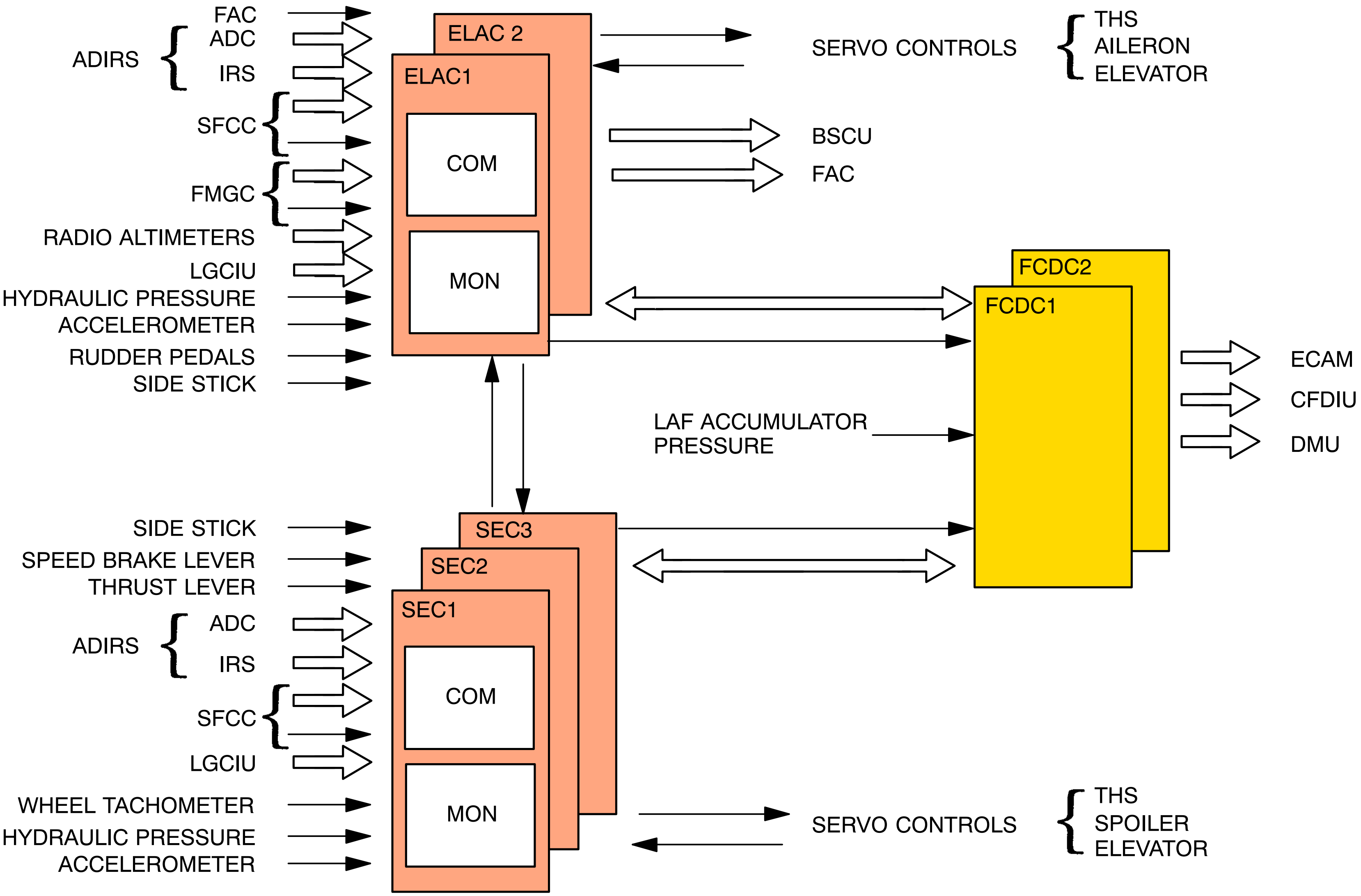


Figure 4 EFCS Interfaces

PANEL DESCRIPTION

Overhead PBSWs

The seven PBSWs control the related flight control computers:

- 2 FACs (**F**light **A**ugmentation **C**omputer 1, FAC2)
- 2 ELACs (**E**levator **A**ileron **C**omputer 1, ELAC2)
- 3 SECs (**S**poiler **E**levator **C**omputer 1, SEC2, SEC3).

Rotary Selector

The rudder trim rotary selector moves the neutral point of the artificial feel unit at a rate equivalent to 1° per second of rudder deflection.

Note that the rudder trim selector is not active when the autopilot is engaged.

Position Indicator

The position indicator displays rudder trim direction and value when the trim is moved automatically or manually.

Reset Pushbutton

By momentarily pressing the reset pushbutton, the rudder trim actuator input returns to zero position and the rudder will follow if hydraulic pressure is available.

Steep Approach P/B (optional A318)

The P/B activates a steep approach function within the SEC.

It allows a different spoiler activation and deflection setting and enables an A318 to operate on specific airports.

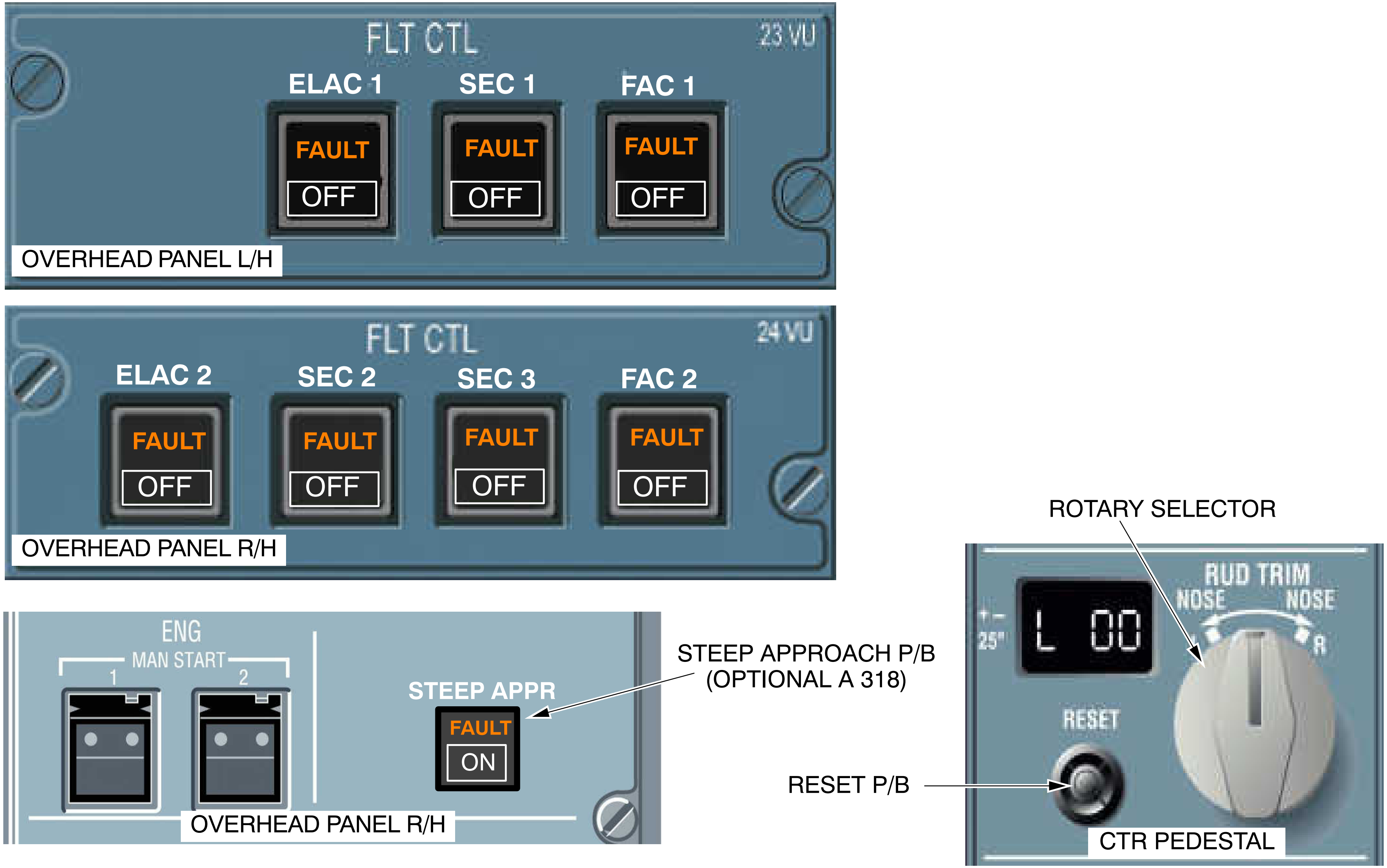


Figure 5 Flight Controls Panel & Rudder Trim

CONTROLS

1 Sidesticks

Sidesticks, one on each lateral console, are used for manual pitch and roll control. They are springloaded to neutral.

The hand grip includes 2 switches:

- A/P disconnect/side stick priority pushbutton.
- Push to talk button.

2 Side Stick Priority Light

Red arrow light:

- Illuminates in front of the pilot losing authority.
- Extinguishes if he has recovered his authority.

Green CAPT – F/O light:

- Illuminates in front of the pilot who has taken priority by pressing the takeover push button if the opposite stick is not at neutral.
- Extinguishes when the opposite stick is returned to neutral position.

3 Pitch Trim Wheels

Both pitch trim wheels provide mechanical control of the THS and have priority over electrical control.

- Trim position is indicated in degrees on a scale adjacent to each trim wheel. Normal range is marked by a green band.

4 Flaps Lever

The Flaps Lever selects simultaneous operation of the slats and flaps. The five lever positions correspond to the surface positions.

- Before selection of any position, the lever must be pulled out of detent. Moving the lever rotates the input shaft of the CSU (**C**ommand **S**ensing **U**nit)

5 Speed Brake Control Lever

The lever controls:

- The position of the speed brake surfaces

  To select speed brake surfaces to a required position the lever has to be pushed down and selected to the required position.
- Manual preselection of the ground spoilers.

  To arm the ground spoilers the lever must be pulled up when in RET position.

6 Rudder Pedals

The two pairs of rudder pedals are connected together. They are linked by a cable loop to the artificial feel unit.

Mechanical rudder control is always available from the rudder pedals.

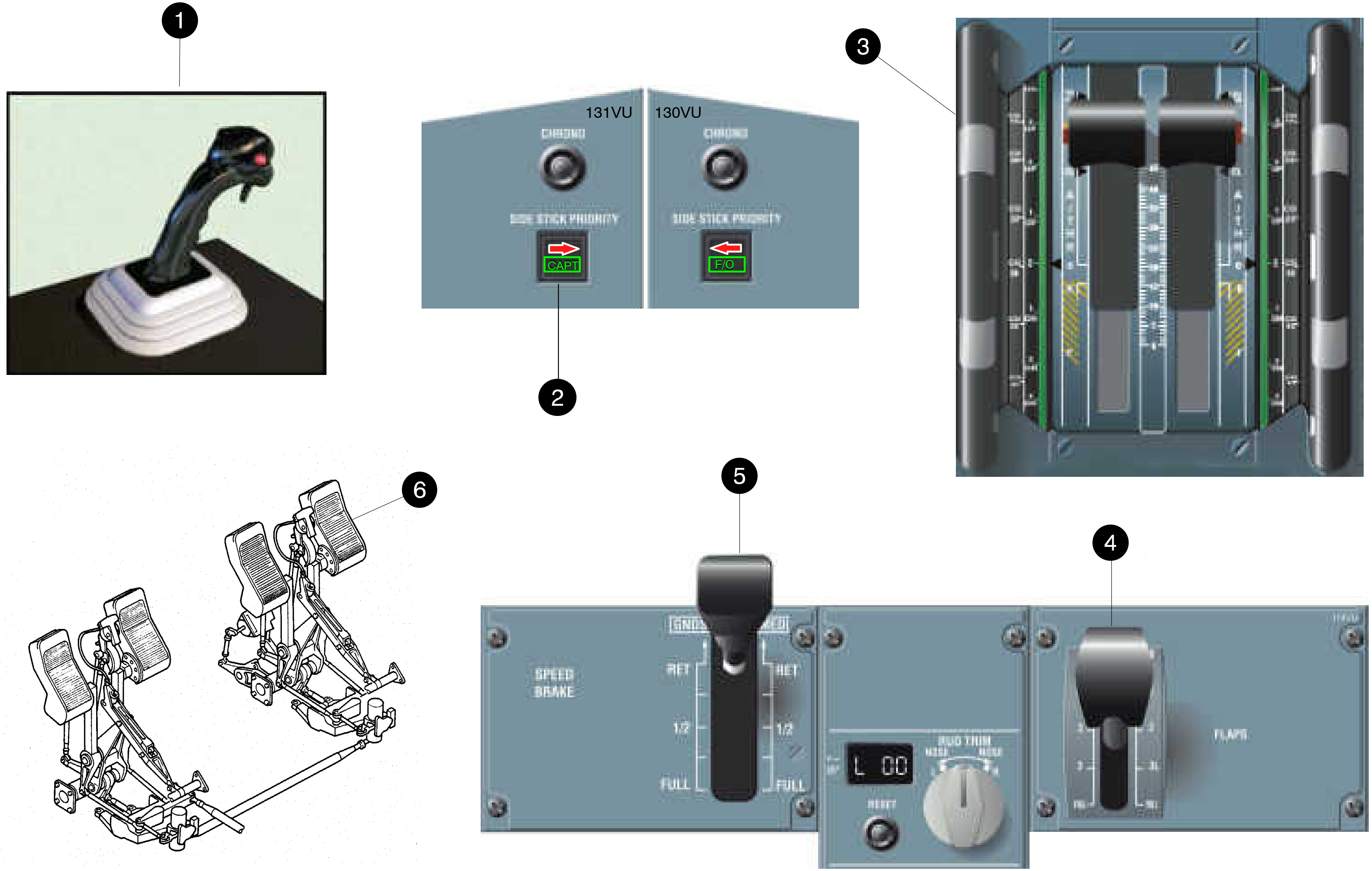


Figure 6 Cockpit Controls

ECAM INDICATION

Spoiler/Speed Brake

	—	green	=	Spoiler deflected more than 2.5 °
—	—	green	=	Spoiler retracted
	—	amber	=	Spoiler fault (deflected)
	—	amber	=	Spoiler fault (retracted)

Each spoiler and speed brake indication is green when the surface is operative and amber when inoperative.

Hydraulic System Pressure

G B Y	—	green	=	System pressure normal
G **B** Y	—	amber	=	Blue actuator not operative due to hydraulic low pressure, jamming

The hydraulic system pressure indication is normaly green and becomes amber in case of low pressure.

ELAC / SEC

ELAC 1	—	green	=	Computer available
ELAC 1	—	amber	=	Computer failed

ELAC: Elevator Aileron Computer
SEC: Spoiler Elevator Computer

The elevator aileron computer and spoiler elevator computer is normally-green and becomes amber in case of failure.

The box is normally grey and becomes amber associated with ELAC/SEC failure indication.

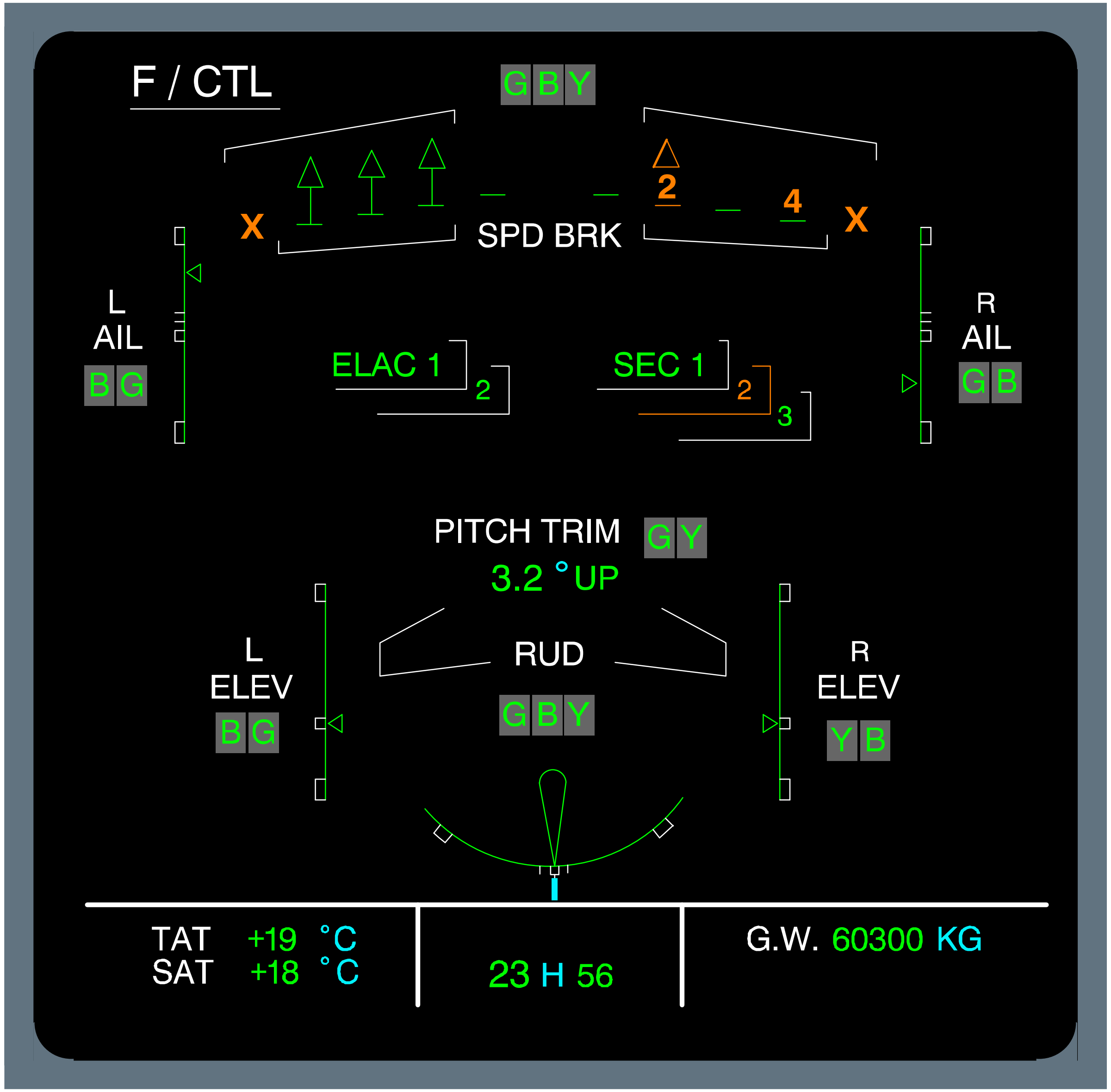


Figure 7 ECAM Flight Control Page

ECAM INDICATION (CONT.)

Aileron

 — green = normal

 — amber = Both aileron servo jacks inoperative

The aileron position is indicated by a green index on a white scale. They become amber if both actuators are inoperative.

Elevator Position

 — green = normal

 — amber = Both elevator servo jacks inoperative

The elevator position is indicated by a green index on a white scale. They become amber if both actuators are inoperative.

Aileron/Elevator Actuator

G B — green = normal

G **B** — amber = Blue actuator not available due to hydraulic low pressure, jamming

G B — amber = Green actuator associated computer failure

The aileron and elevator actuator indications normally green becomes amber if the related actuator is inoperative.

Pitch Trim Position

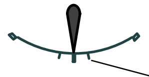
3.2°UP — green = normal

3.2°UP — amber = Both hydraulic motors inoperative

The pitch trim position is normally green and becomes amber in case of green and yellow hydraulic system low pressure.

The PITCH TRIM word is normally white. It becomes amber in case of THS jar

Rudder Position

 — green = Rudder operative

Rudder limiter high speed position (fixed symbol)

 — amber = In case of three hydraulic systems low pressure

 — cyan = Rudder trim actuator actual position

Rudder trim indicator

 — amber = Rudder trim reset failed

The rudder position indication is normally green and becomes amber in case of blue, green and yellow hydraulic low pressure.

LAF Degraded (A320 only)

The indication appears amber when LAF normal law can not be achieved due to failure of LAF hydraulic accumulator, ELAC ,SEC, aileron/spoiler servo, ect.

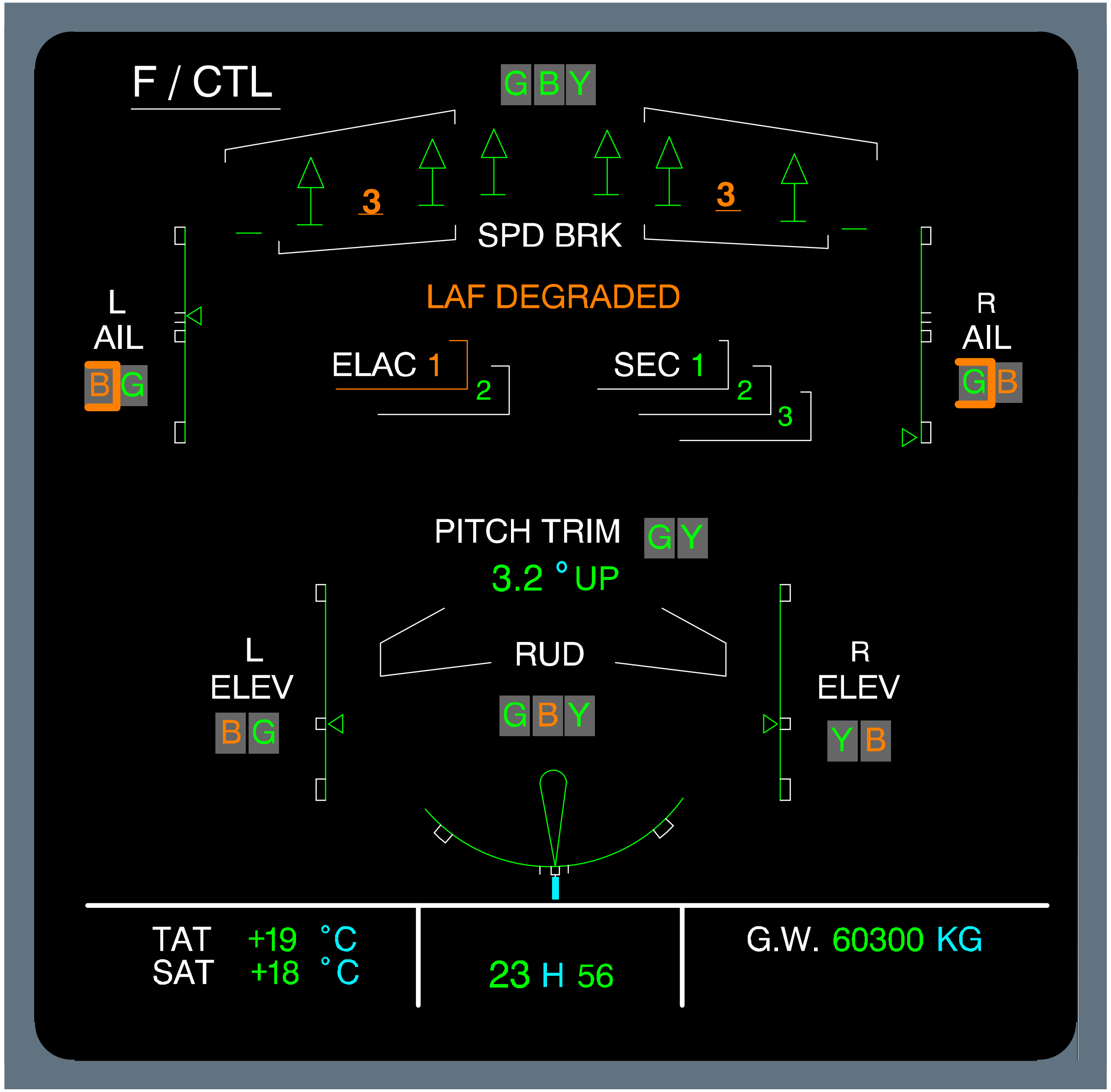


Figure 8 ECAM Flight Control Page

ECAM INDICATION (CONT.)

1 FLAP Indication

FLAP indication appears when the slats or the flaps are not fully retracted

- White when selected position is achieved
- Cyan when flaps or slats in transit
- Displayed amber in case of:
  - both relevant hydraulic systems loss (except on ground with Eng. stopped)
  - wing tip brake application
  - slats or flaps fault

2 Flap Lever Position

- 0, 1 + F, 1, 2, 3, or FULL indication is displayed. Refer to CONTROLS and INDICATORS on pedestal
  - Green when selected position is achieved. POS " 0 " not displayed when clean configuration is achieved
  - Cyan during transit
- S (F) LOCKED indication appears amber associated with ECAM caution when wing tip brakes are applied or when non alignment between 2 flaps is detected.
- A–LOCK indication pulses cyan when the slat alpha/speed lock function is active.

3 Slats Flaps Position

White points – Selectable position. Not displayed in clean configuration.

4 Green Triangles = Actual Position

Displayed in amber in case of:

- both relevant hydraulic systems loss (except on ground with Eng. stopped)
- wing tip brake application
- slats or flaps fault

5 Blue Triangles = Selected Position

Disappear when the selected position is reached.

6 S, F Indication

- Normally green
- Displayed amber in case of:
  - both relevant hydraulic systems loss (except on ground with Eng. stopped)
  - wing tip brake application
  - slats or flaps fault

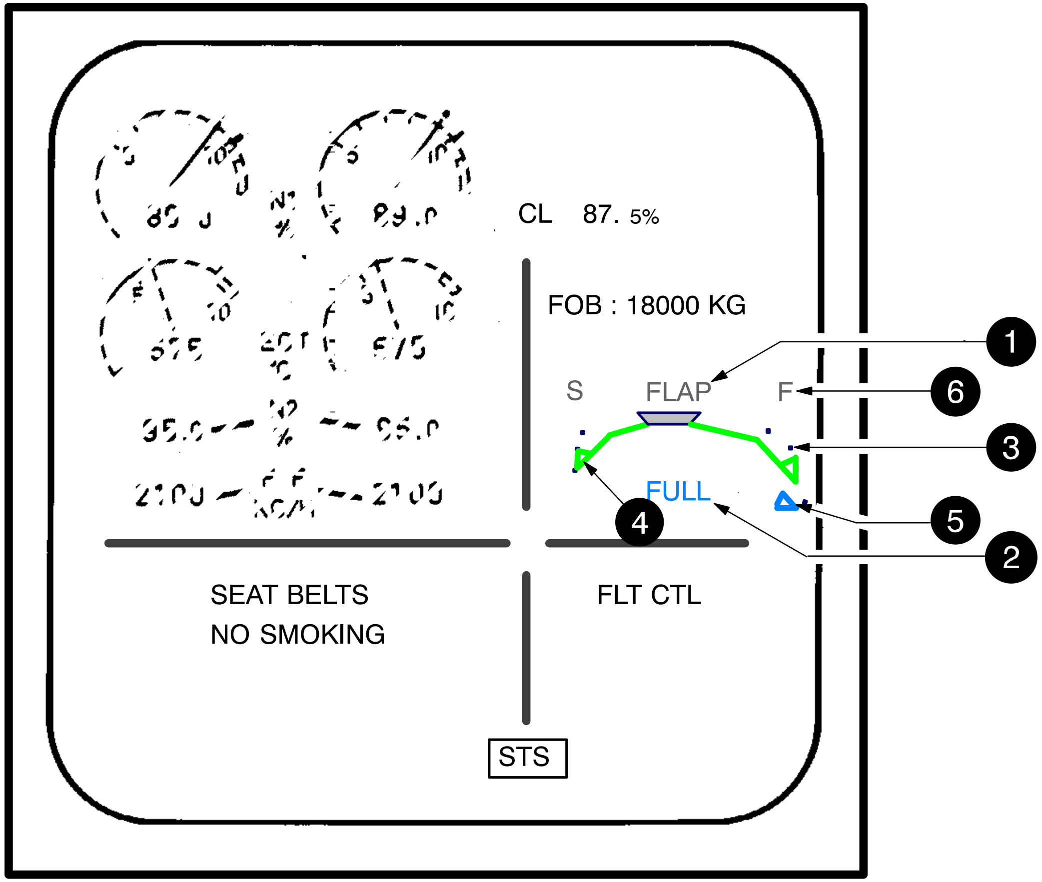


Figure 9 ECAM Eng. & Warning Display

FLIGHT CONTROL SYSTEM ARCHITECTURE

General

All the flight control surfaces are now electrically controlled and hydraulically operated. In addition, the stabilizer and the rudder have hydromechanical control back-up in case of electrical failure.

Depending on condition the Servo Control Units (SCUs) 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

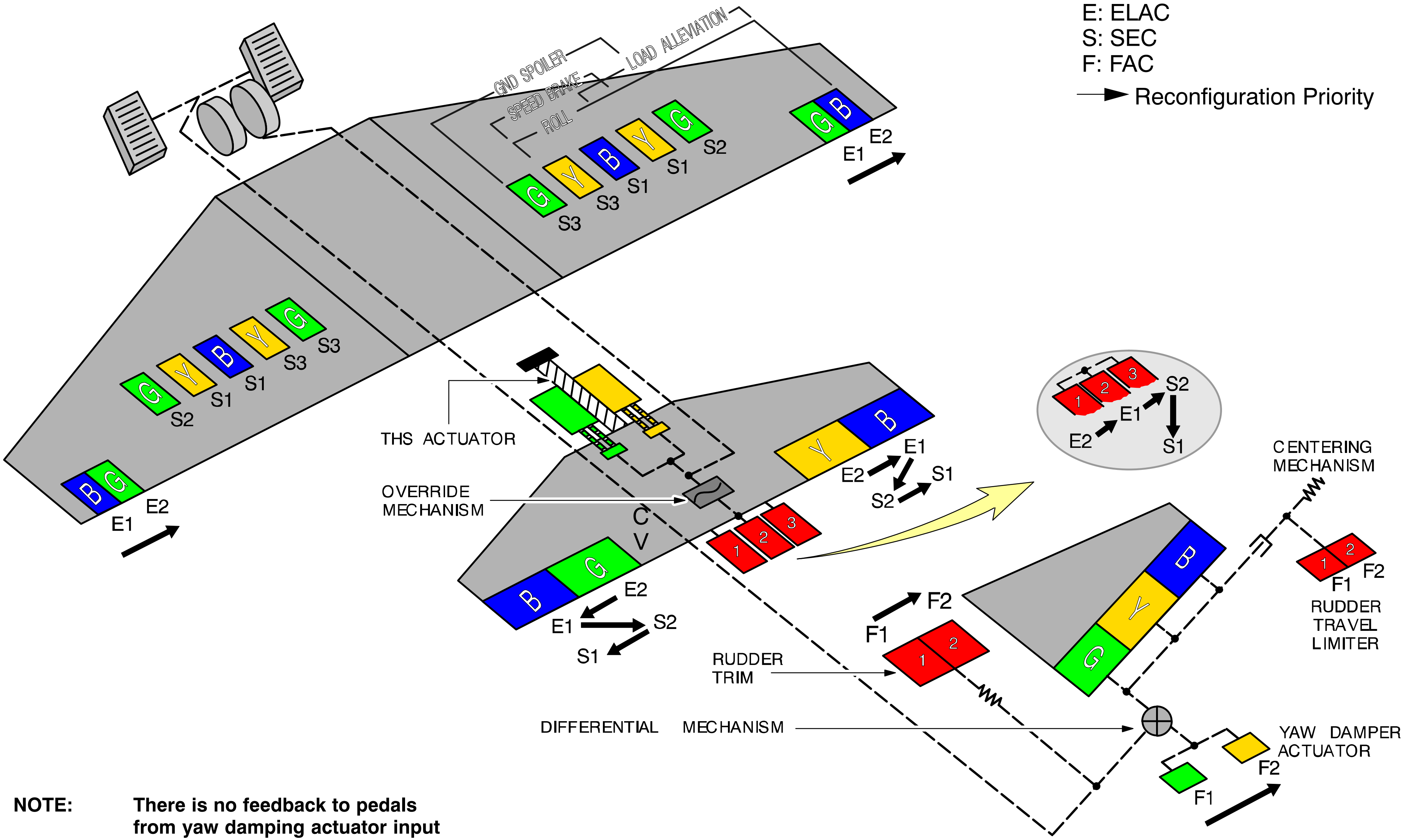
Since the Rudder actuators have only mechanical inputs via spring rods they are always operating in parallel in Active Mode if hydraulic power is available and in Damping Mode if hydraulic pressure is lost.

Yaw Damper Actuator

The actuators can operate in two different modes:

Active Mode

By-Pass Mode



NOTE: There is no feedback to pedals from yaw damping actuator input

Figure 10 Flight Control Basic Schematic

FLIGHT CONTROLS HYD PWR SUPPLY

The flight controls are powered by the three independent hydraulic systems. Redundancy is such that with two hydraulic systems failed, the remaining system can operate the aircraft within an acceptable range of the flight envelope.

Hydraulic characteristics of flight control components are given in the component description paragraphs.

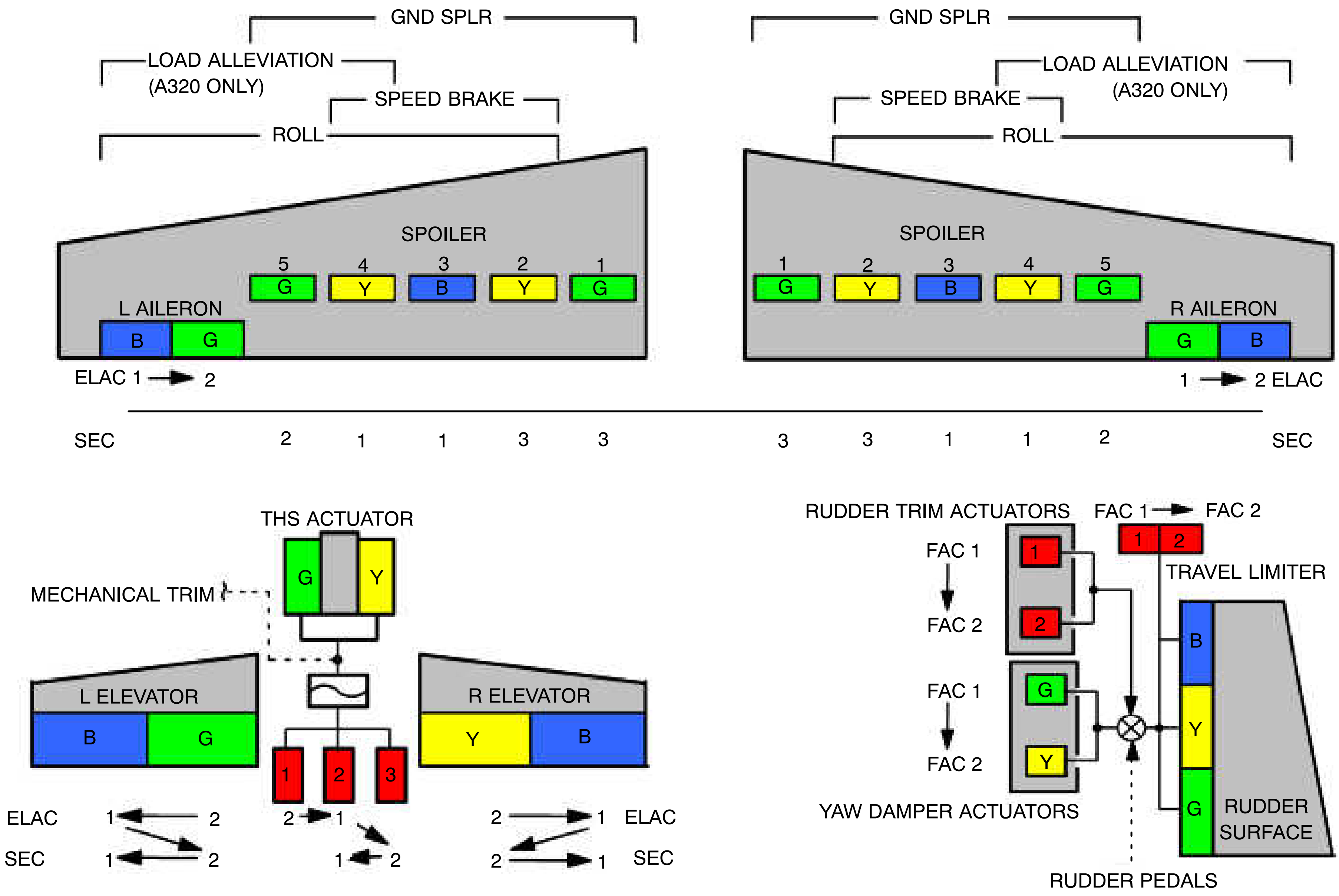


Figure 11 Hydraulic Supply Schematic

ELECTRICAL PWR. SUPPLY FUNCTIONAL OPERATION

Flight Controls Electrical Power Supply

The ELAC 1 and SEC 1 are each supplied from a DC essential busbar (4PP for the ELAC 1 and SEC 1), the battery 1 taking over instantaneously through a dedicated diode device (Power Supply Uncoupling Unit) when the voltage level drops below the battery output voltage.

A relay ensures the battery supply line breaking on ground 30sec after the second engine shut down.

The ELAC 2 and the THS motor 1 are normally supplied from the DC normal busbar 2PP.

In case of loss of this busbar (particularly after the loss of both main generation channels, or after a double main TRU failure), these supplies are automatically switched over to the battery 2 by means of two relays, for a fixed period of 30 sec.

The SEC 2, the SEC 3, the THS electric motor 3 and FCDC 2 are supplied from the normal busbar 2PP.

The THS electrical motor 2 is supplied from the DC essential busbar 4PP.

The FCDC 1 is supplied from the DC essential busbar 8PP.

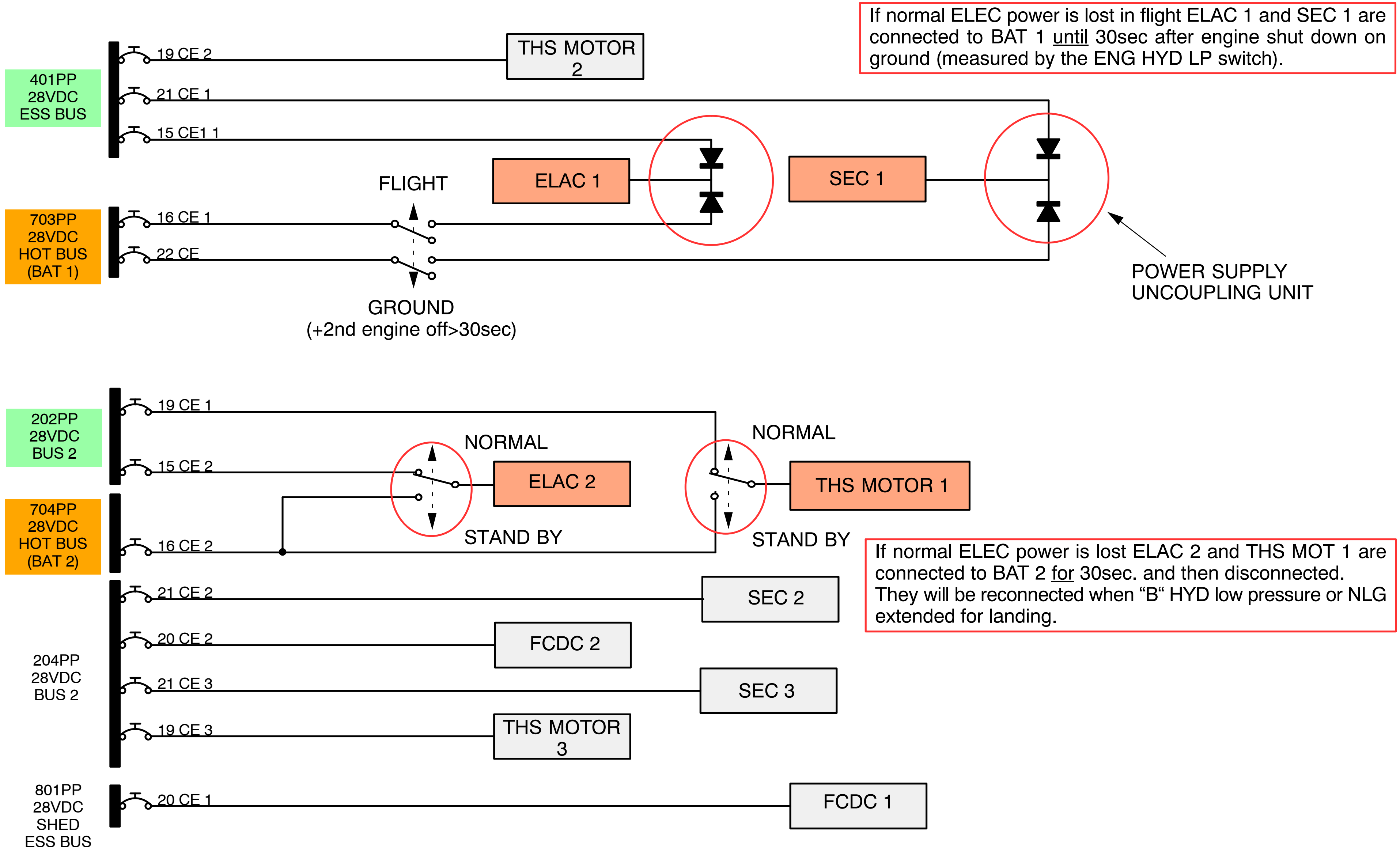


Figure 12 Electrical Power Supply

27-90 ELECTRICAL FLIGHT CONTROL SYSTEM (EFCS)

CONTROL LAWS PRESENTATION

The different control laws and associated protections, may be used depending on the integrity of the flight control and flight augmentation systems and their peripherals. They are implemented in the computers.

Roll Normal Law

This is the combined control of the ailerons, spoiler surfaces 2 to 5 and rudder from the sidestick controllers coupled according to the priority logic. In flight, it achieves the control and limitation of the roll rate, providing a neutral spiral stability up to a given bank angle, the turn coordination and the dutch roll dam−ping. It requires gains depending on the flight/ground condition, airspeed and configuration.

On the ground it provides a fixed relationship between the side stick controller angle and the aileron and spoiler deflection.

Roll Direct Law

This is the control of the aileron and spoiler surfaces 2 to 5 from the side stick controllers coupled according to the priority logic. It achieves the control of the above surface angles using gains depending on the configuration.

A limited−authority dutch roll damping function is given.

Pitch Normal Law

This is the combined control of the elevators and the THS from the side stick controllers coupled according to the priority logic to achieve the load factor control. It requires load factor and pitch attitude rate feedback, variable gains depending on flight/ground condition, radio altimeters, airspeed and configuration.

It includes an high angle−of−attack protection, a load factor limitation and an overspeed protection.

On the ground it provides a fixed relationship between the side stick controller angle and the elevator deflections.

Pitch Alternate Law

This is the operation of the elevators and the THS, if operative, from the side stick controllers coupled according to the priority logic to achieve the load factor control.

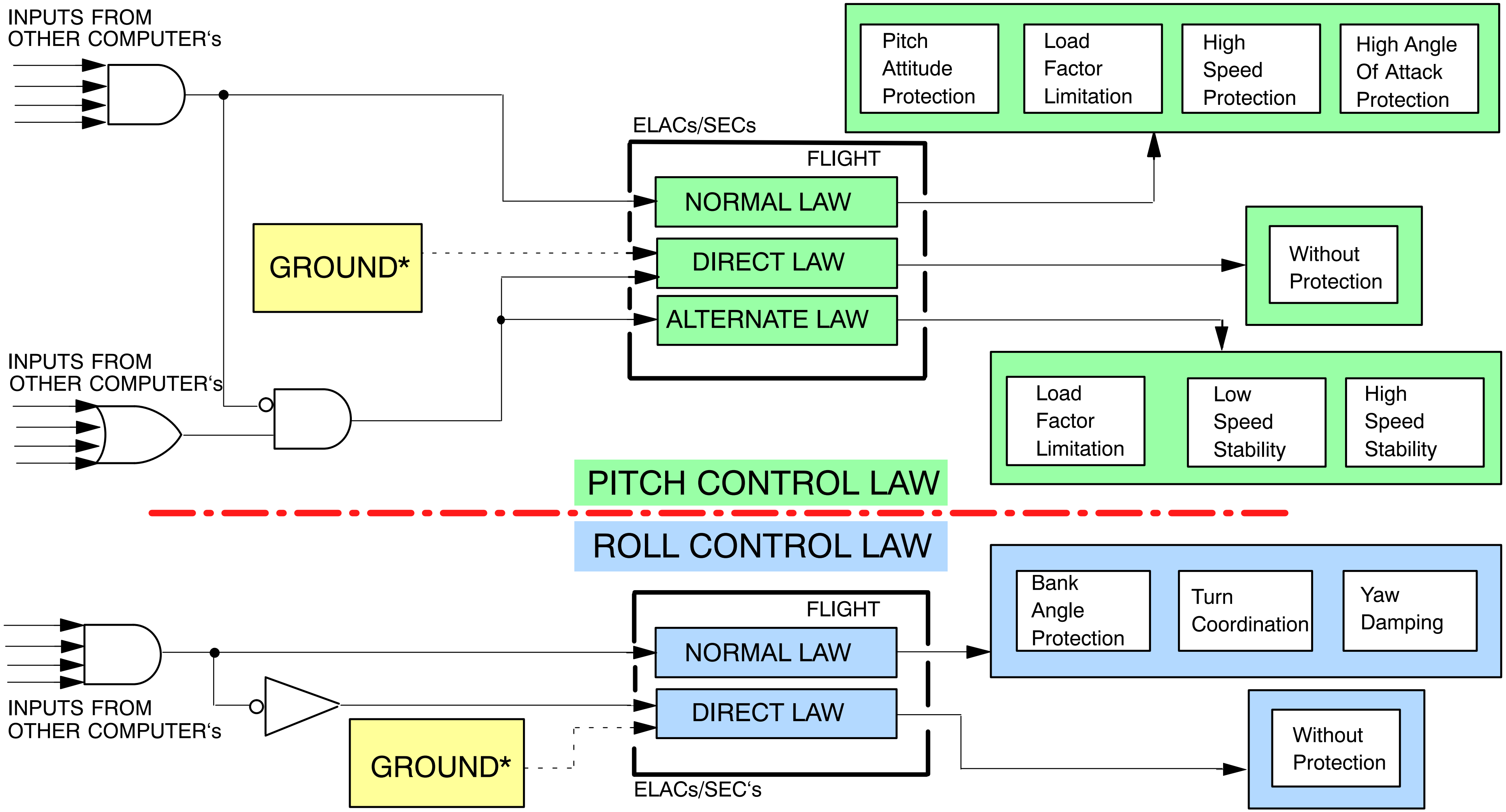
It uses limited authority load factor and pitch rate feedback and gains depending on the configuration.

It includes a load factor limitation that cannot be overridden by the crew and alternate protections.

Pitch Direct Law

This is the control of the elevator angle from the side stick controllers coupled according to the priority logic with a gain depending on the configuration.

Pitch trim can be achieved via the mechanical control of the THS.



* The GROUND mode is basically a function of the NORMAL LAW mode.
On ground it leads to a fixed STICK TO SURFACE RELATION similar to DIRECT LAW.
In real DIRECT LAW the surface activation may be different to GROUND MODE (e.g. ADIRS OFF on GRD is a real DIRECT LAW and not all spoilers are active).

Figure 13 EFCS Control Laws

27-92 CONTROL INPUTS INTERFACES

SIDE STICK CONTROLLER COMPONENT DESCRIPTION

Description

Two side stick controllers are used for pitch and roll manual control one on the captain lateral console, another one on the first officer lateral console. The two side sticks are electrically coupled. General concept is a fail safe concept i.e. mainly that a single failure provides:

- neither total loss of artificial feel
- nor undetected uncontrolled pilot order.

The side stick includes:

- a hand grip
- a protection boot
- two axes
- two spring rods for pitch artificial feel
- two springs for roll artificial feel.
- two transducer units ; one for roll, the other one for pitch one solenoid to introduce; in AP mode, a higher threshold to move the side stick out of the zero position.

The hand grip includes 2 switches:

- A/P disconnect pushbutton is used for:
  - A/P disconnection in A/P mode
  - Priority logic between sticks in manual mode
- Push−to−talk button.

Transducer Units associated to Side Stick Controllers

- Two identical transducer units are associated to each controller one for roll control, another one for pitch control.
- Four sets of 3 plastic track potentiometers are fitted in each unit.
- The design is fail safe from the mechanical inputs (two input levers) to the input drive of each potentiometer set. The purpose of this design is to avoid the loss of the mechanical drive of more than one potentiometer set subsequent to a single mechanical failure.
- The gear ratio between unit input and potentiometer sets is 3.

The unit mid stroke position is accurately determined by a rigging pin between input levers and the body. The potentiometers are rigged to mid stroke for this input lever position in the unit manufacturer facilities.

Then no electrical rigging is needed when a transducer unit is replaced. The hand grip being maintained to zero by artificial feel threshold and the unit input being fixed to mid stroke by the pin,the length of the two input rods is adjusted to connect each of them to the corresponding input lever.

The rigging pin is removed after mechanical connection is achieved.

Ten potentiometers are used in each transducer unit used for roll control, one potentiometer being associated to each COM and each MON unit of the 2 ELACs and 3 SECs. The COM and MON units of each computer do not use potentiometers of the same group.

Only 8 potentiometers, 2 in each group, are used in each transducer unit used for pitch control.

They are associated to the two ELACs and to SEC 1 and 2. The COM and MON units of each computer use potentiometers of the same group.

Each potentiometer track power supply is achieved by the associated computer unit.

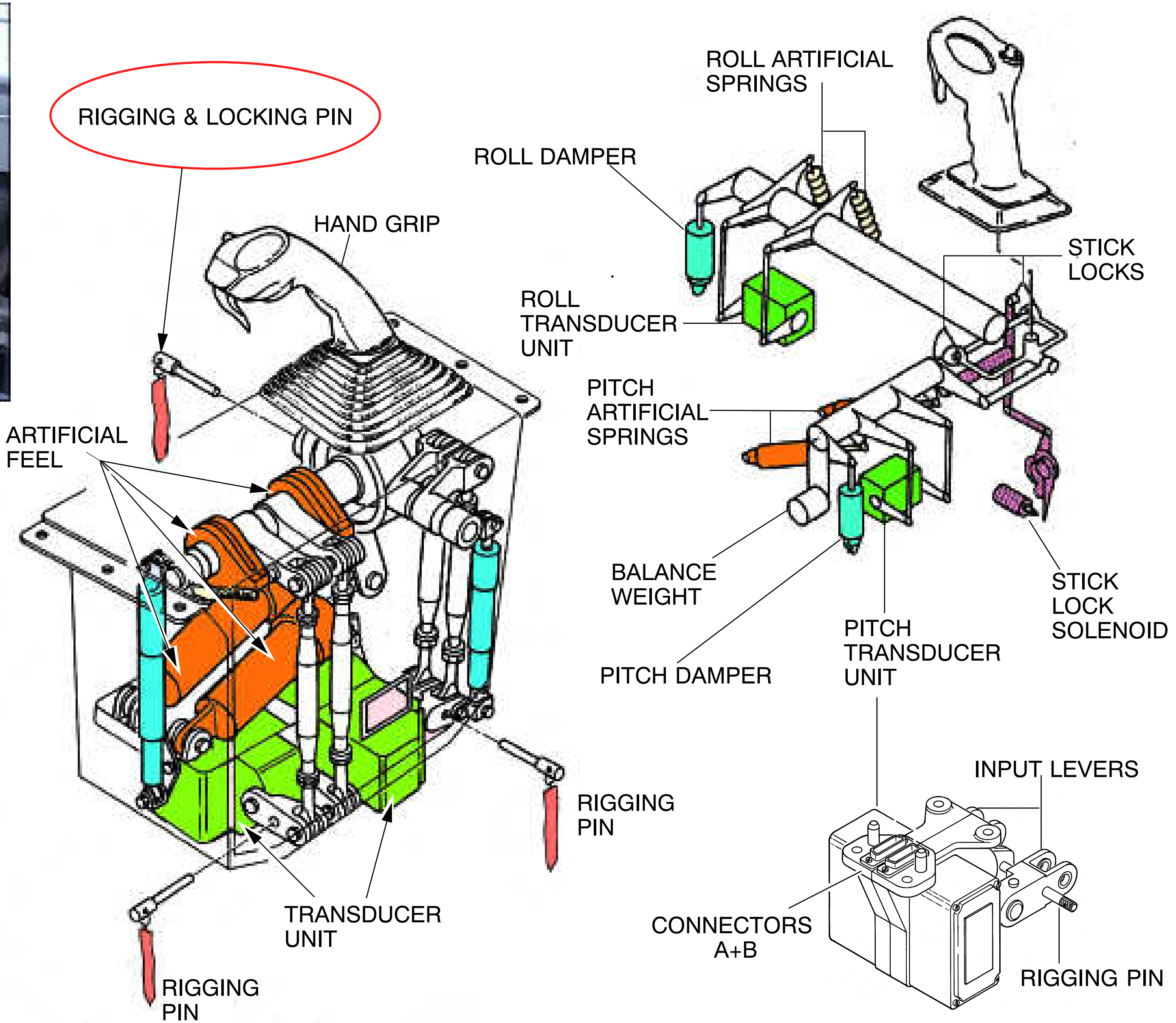


Figure 14 Side Stick Assembly

SIDE STICK PRIORITY LOGIC

Side Stick

The two side sticks are mechanically independent.

[1] They are spring loaded to neutral.

Operation

[2] The RH stick is moved first:

When a side stick is moved, an electrical signal related to the angle of deflection is sent to the system computers ELACs and SECs.

[3] Some demand is added with the LH stick:

When both side sticks are moved in the same direction, these signals are added. The sum is limited to single stick maximum deflection.

[4] The LH side stick is moved in opposite direction now:

If the side sticks are moved in opposite directions, the resulting surface movement is the difference between them.

[5] The LH take over push button is depressed:

By depressing and keeping depressed his take over push button, a pilot will deactivate the other side stick.

A green light will come on in front of the pilot who maintains control as long as the other stick is not in neutral position.

A red light will come on in front of the pilot whose stick is deactivated.

The RH side stick is released to neutral:

When the deactivated side stick is released to neutral, the green light extinguishs.

[6] Now, the LH take over push button is released:

When the take over push button is released, the red light goes out and both side sticks become active again.

NOTES:

1. At any time, momentarily depressing the take over push button of a deactivated side stick will reactive it and maintaining this button depressed will provide priority.
2. After 30 seconds, the system is latched and it is not longer necessary to keep the take over push button depressed to maintain the priority.
3. The side stick indication is generated by the Flight Controls Data Concentrators
4. The side stick priority will be confirmed by a call out ”PRIORITY LEFT or PRIORITY RIGHT” generated by the Flight Warning Computer.
5. If both sidesticks are moved together a call out “DUAL INPUT“ is generated and green lights appear in front of both pilots.
6. The take over push buttons also serve for autopilot disconnect.

Side Stick Indication on PFD

On ground, after first engine start, side stick position indication appear white on CPT and FO PFD.

The indication disappears when the aircraft passes from ground to flight.

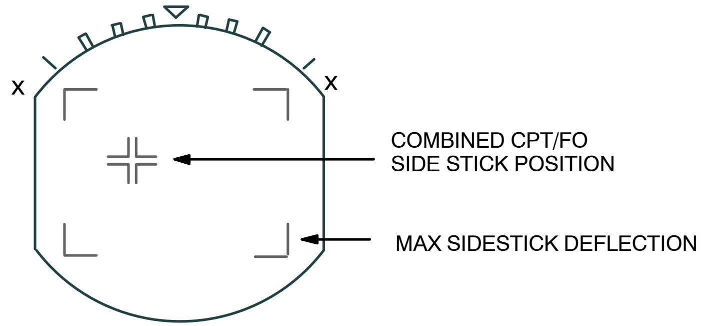


Figure 15 Side Stick Indication on PFD

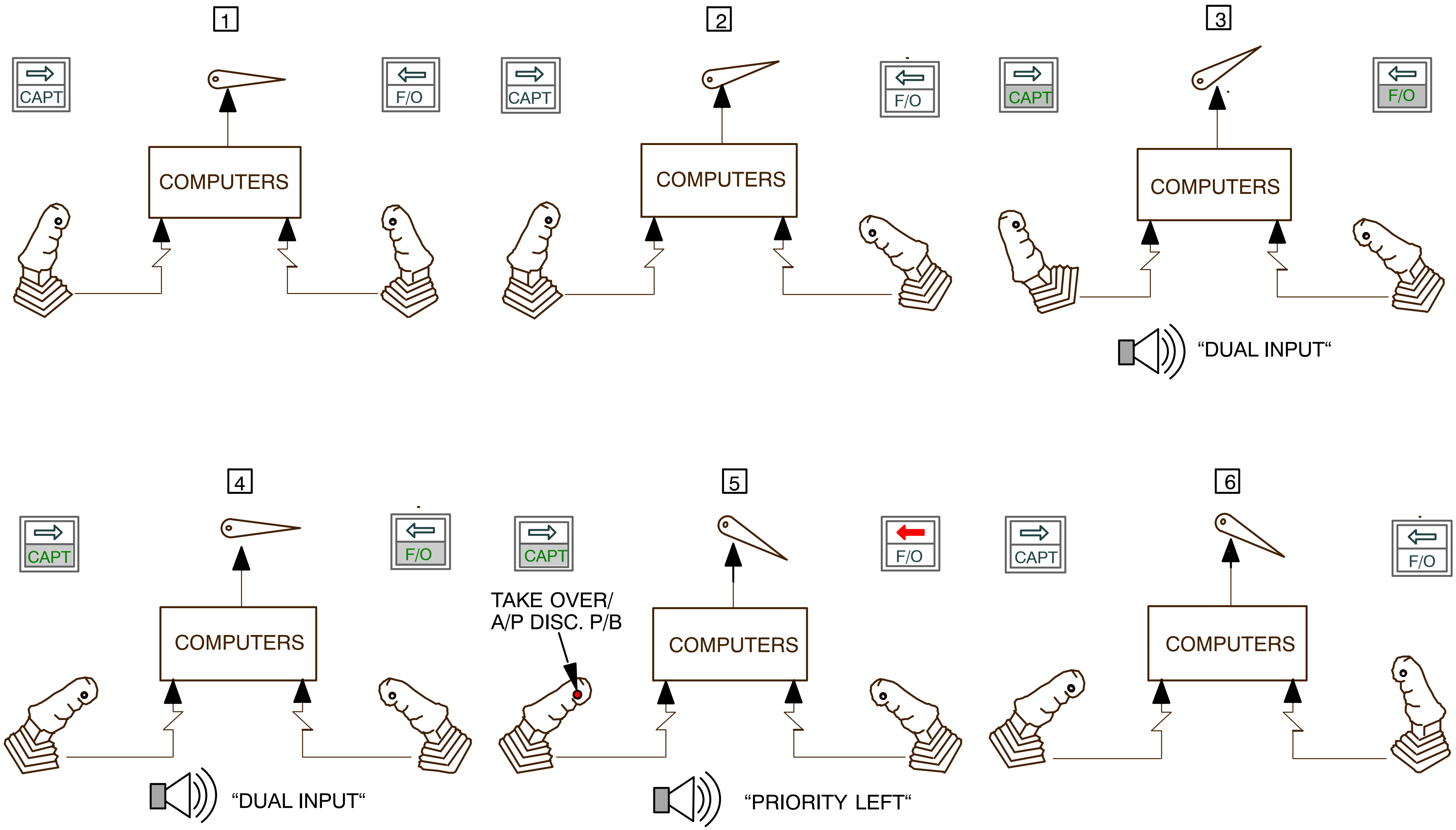


Figure 16 Side Stick Priority Logic

27−10/60 AILERON/SPOILER

ROLL CONTROL DESCRIPTION

System Description

Roll control is achieved by one aileron (operational at all speeds) and four spoilers on each wing.

The ailerons are manually controlled from the side stick controllers or automatically in A/P or Load Alleviation Function (if installed).

Five spoilers numbered 1 thru 5 inboard to outboard are provided on the rear upper surface of each wing. These surfaces are manually controlled from the side stick controllers (roll spoilers), speed brake control lever (speedbrakes) or automatically in A/P, ground spoiler or Load Alleviation Function.

The combination of the different functions is achived in the computers.

The spoilers 2, 3, 4 and 5 assist the ailerons in roll control.

Full authority of surface is ± 25° for the ailerons and − 35° for the spoilers.

Ailerons

Each aileron can be actuated by two different servo controls. In normal operation, one servocontrol per aileron is active (controlled by ELAC 1), the other is in damping mode

- on the left aileron, the blue servo control is active
- on the right aileron, the green servocontrol is active

The servocontrols, controlled by the ELAC 2 , green on the left side and blue on the right side are in damping mode.

A 5° downward deflection of the ailerons (droop) is active when the flaps are extended. This position is identified by an index on the AIL scale of the ECAM F/CTL page. The aileron droop function is available as long as one ELAC is able to control the ailerons.

Depending on ELAC software status the ailerons are fully extended after touchdown if both ailerons are available, the GRD spoilers are fully extended, flaps are not in clean config., pitch is below 2.5 deg and normal law is active. This function is used to support the GRD spoiler function and not active on NEO aircraft.

The ailerons are normally controlled by the ELAC 1, the ELAC 2 is in standby and the associated servocontrols are in damping mode. In case of ELAC 1 failure, the control of the ailerons is automatically transferred to the ELAC 2 which becomes active through the left green and right blue servocontrols.

In that case the servocontrols dedicated to the ELAC 1 revert to the damping mode.

In case of double ELAC failure, or blue and green hydraulic system low pressure, all ailerons are in the damping mode.

An ELAC can be engaged in lateral if at least one of the two servoloops is valid. An servoloop is declared valid when the result of several monitorings (i.e. servo valve current, servocontrol position transducer, discrete links between the computers ect.) is satisfactory.

If ELAC 1 can only drive one aileron, the ELAC 2 drives the other aileron from the order computed by the ELAC 1.

Spoilers

Each surface is actuated by one servo control supplied from either the green, yellow or blue hydraulic system.

The electrical spoiler control is achieved by:

- SEC 1 for spoiler 3 and 4
- SEC 2 for spoiler 5
- SEC 3 for spoiler 1 and 2

Surfaces are automatically retracted to zero position when a fault is detected by the corresponding computer or when not electrically controlled.

In case of loss of hydraulic supply the surface remains at the existing deflection or less if pushed down by aerodynamic forces.

A SEC can be engaged on a pair of spoilers when two servoloops are valid. The servoloops of a pair of spoilers is valid when the result of the monitorings is satisfactory for position transducers function and servovalve current.

In normal configuration the SECs control their related spoilers (roll function) from the orders from the normal lateral law of the ELACs. In case of a double ELAC failure, the SECs generate the roll spoiler deflection depending on side stick controller signals.

The position of spoilers and ailerons are indicated on the lower ECAM display unit F/CTL page via the FCDC.

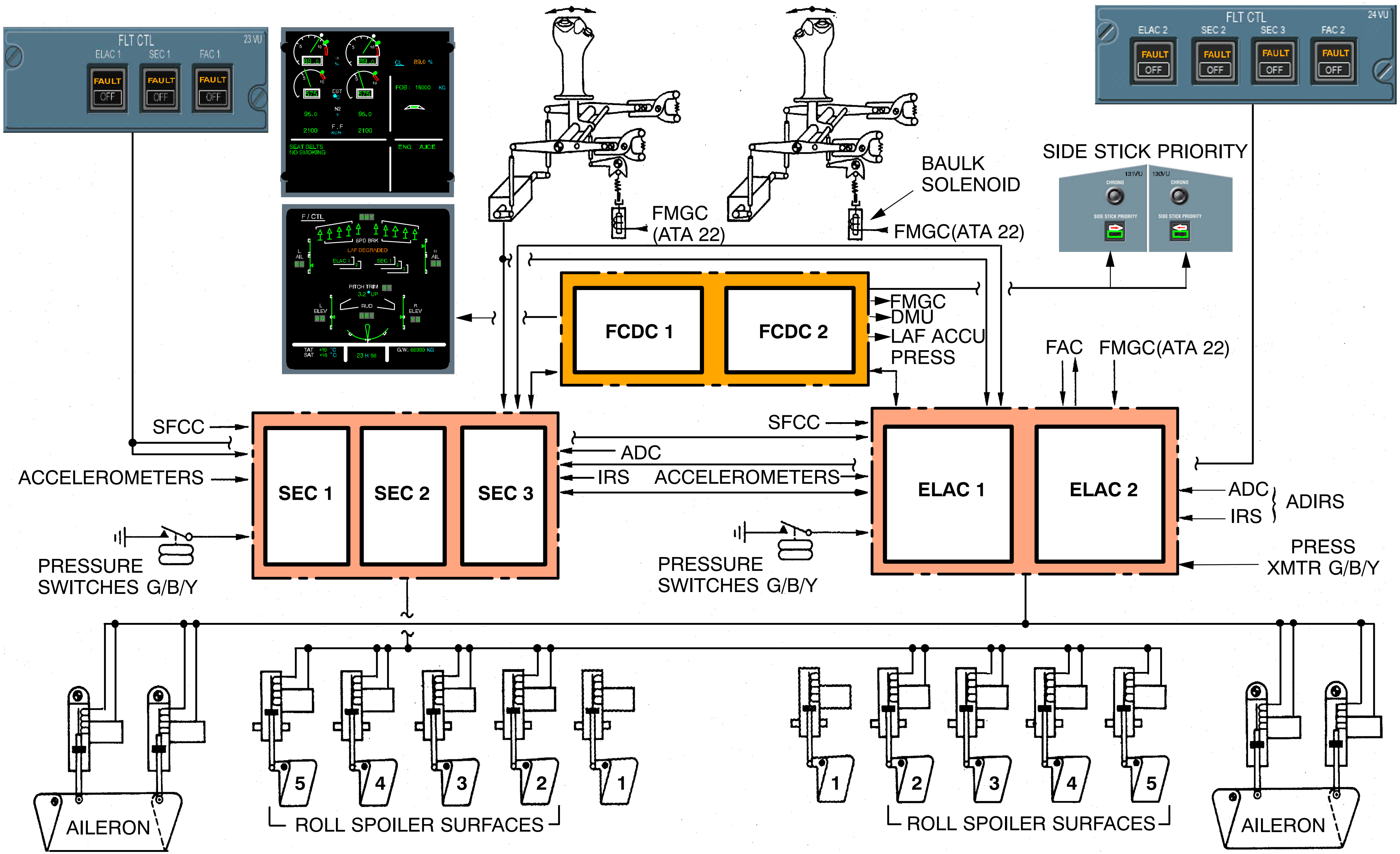


Figure 17 Roll Control Schematic

27−10 AILERON

AILERON SCU COMPONENT DESCRIPTION

General

The Aileron servo actuator units are mounted in the wing trailing edge with the actuator piston connected to the aileron. The four units are equal and interchangeable.

The servo actuator is controlled from the ELAC in command. During power−up test, the solenoid valve is powered on the active actuators and steering control signal is send to the servo valve, on the same time the LVDT loops are monitored for proper feed−back signal.

The servo actuator will operate in two different modes:

- Active
- Damping

Active Mode

Activation of the unit requires power to the solenoid valve (1). This will cause the pressure line closing valve (2) and the return line closure valve (3) to open and the mode selector valve (5) will change to active position. The LVDT (11) supplies a signal identifying this position.

The two chambers of the actuator are now connected to the servo valve (4), controlled by the ELAC. The feedback transducer (10) gives the servo loop feedback.

Damping Mode

The solenoid valve is de-energized. The mode selector valve moves to the relaxed position by the spring. The two chambers are now interconnected through the damping orifice (6).

In case of electrical failure the solenoid will de-energize and the unit goes to damping mode. In case of loss of hydraulic pressure the pressure and return line closing valve will close, causing the unit to revert to damping mode.

The servo valve, solenoid valve and the mode selector valve are all LRU's. After replacement of the servo valve, adjustment of the feed back transducer is required. A adjustment device is located on the actuator piston end (adjusting nut).

Aileron Servo Valve

The aileron command from the ELAC is received by the servo control valve. The valve consist of a jet nozzle spring loaded to the neutral position.

The steering signal from the ELAC will activate the magnetic coil and reposition the jet nozzle sending the hydraulic pressure to one of the sides on the control sleeve.

The control sleeve will guide the hydraulic pressure to either side of the aileron actuator and will connect the other side to return.

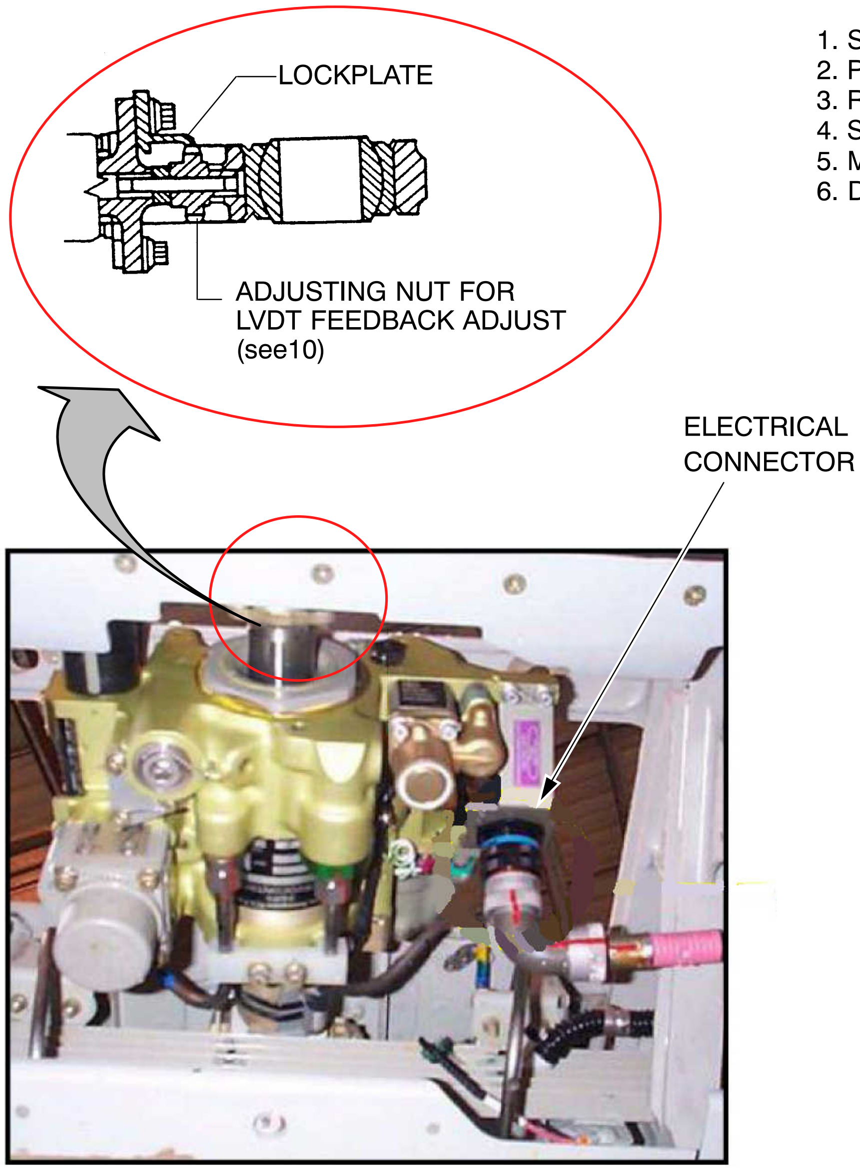
Steering feed back signal to the ELAC is transmitted by the feedback transducer located inside the aileron actuator

MEL and Deactivation

As aileron servocontrol is a MMEL item, its deactivation is performed by disconnecting the related electrical connector.

The detailed procedure is given in the AMM.

1. SOLENOID VALVE
2. PRESSURE LINE CLOSING VALVE
3. RETURN LINE CLOSING VALVE
4. SERVO VALVE
5. MODE SELECTOR VALVE
6. DAMPING ORIFICE
7. CHECK VALVE
8. RETURN RELIEF VALVE
9. FLUID RESERVE
10. FEEDBACK TRANSDUCER
11. MODE SELECTOR VALVE TRANSDUCER



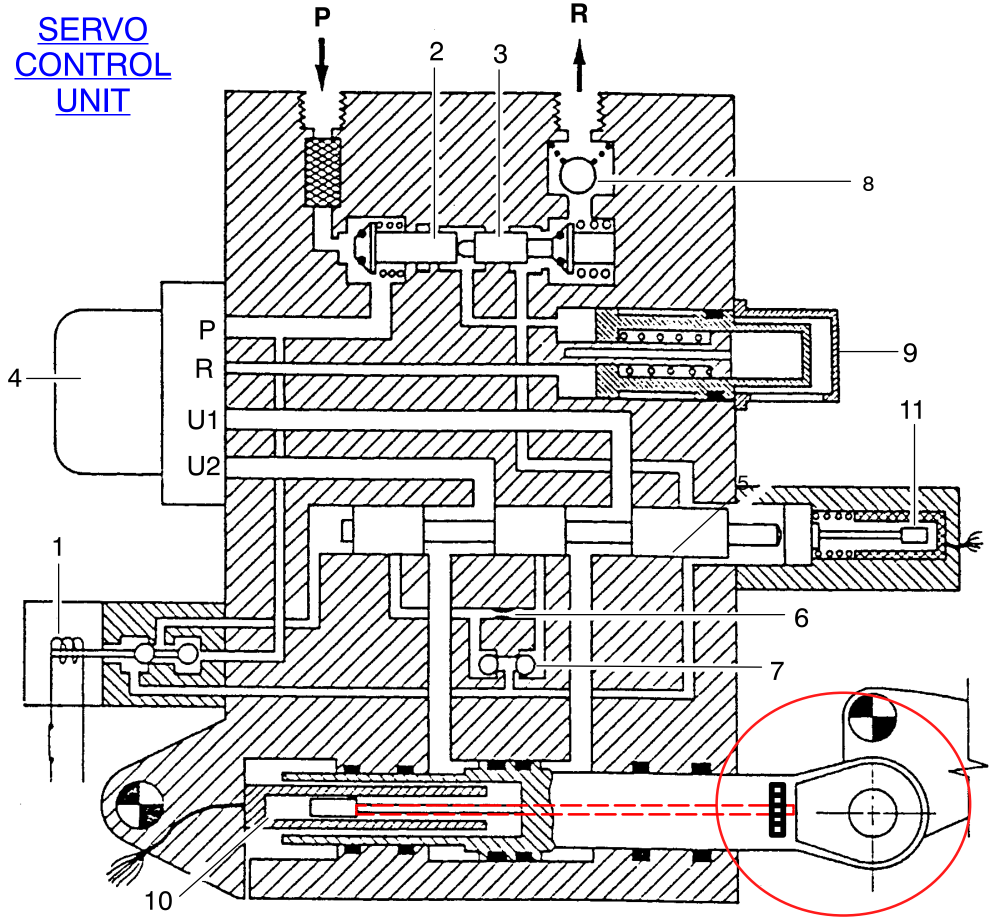


Figure 18 Aileron Servo Control Unit

27–90 ELECTRICAL FLIGHT CONTROL SYSTEM (EFCS)

ROLL NORMAL LAW FUNCTIONAL OPERATION

General

The roll normal law is the basic law for roll and yaw control. The various modes of the roll normal law and their switchover conditions are presented here after.

Roll Normal Law (Ground Mode)

On ground a direct stick to surface relationship is used. Pitch trim is manually set. Autotrim is inhibited.

On the PFD, the white cross shows combined captains and first officer side stick position. The corners are the maximum side stick deflection.

Roll Normal Law (Flight Mode)

In flight mode the roll normal law provides combined control of the ailerons,spoilers 2 to 5 and rudder (for turn coordination) from the sidestick.

It achieves the control and limitation of the roll rate, bank angle protection, turn coordination and dutch roll damping.

The roll rate demanded in flight by the pilot is proportional to the side stick deflection and is limited on the stop to 15°/s.

Not overrideable limitation symbols are displayed green on the PFD.

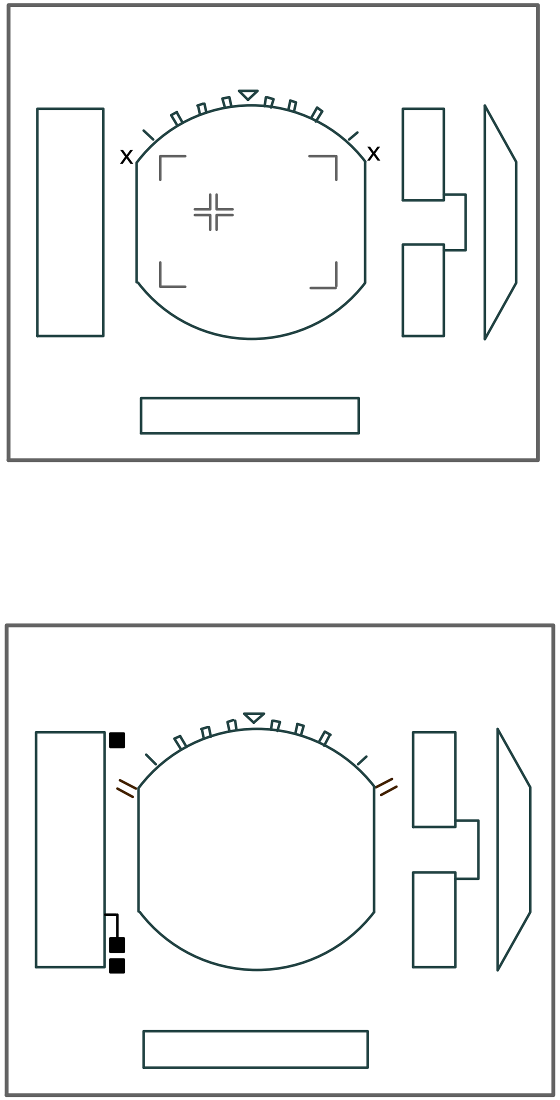


Figure 19 PFD – Roll Normal Law

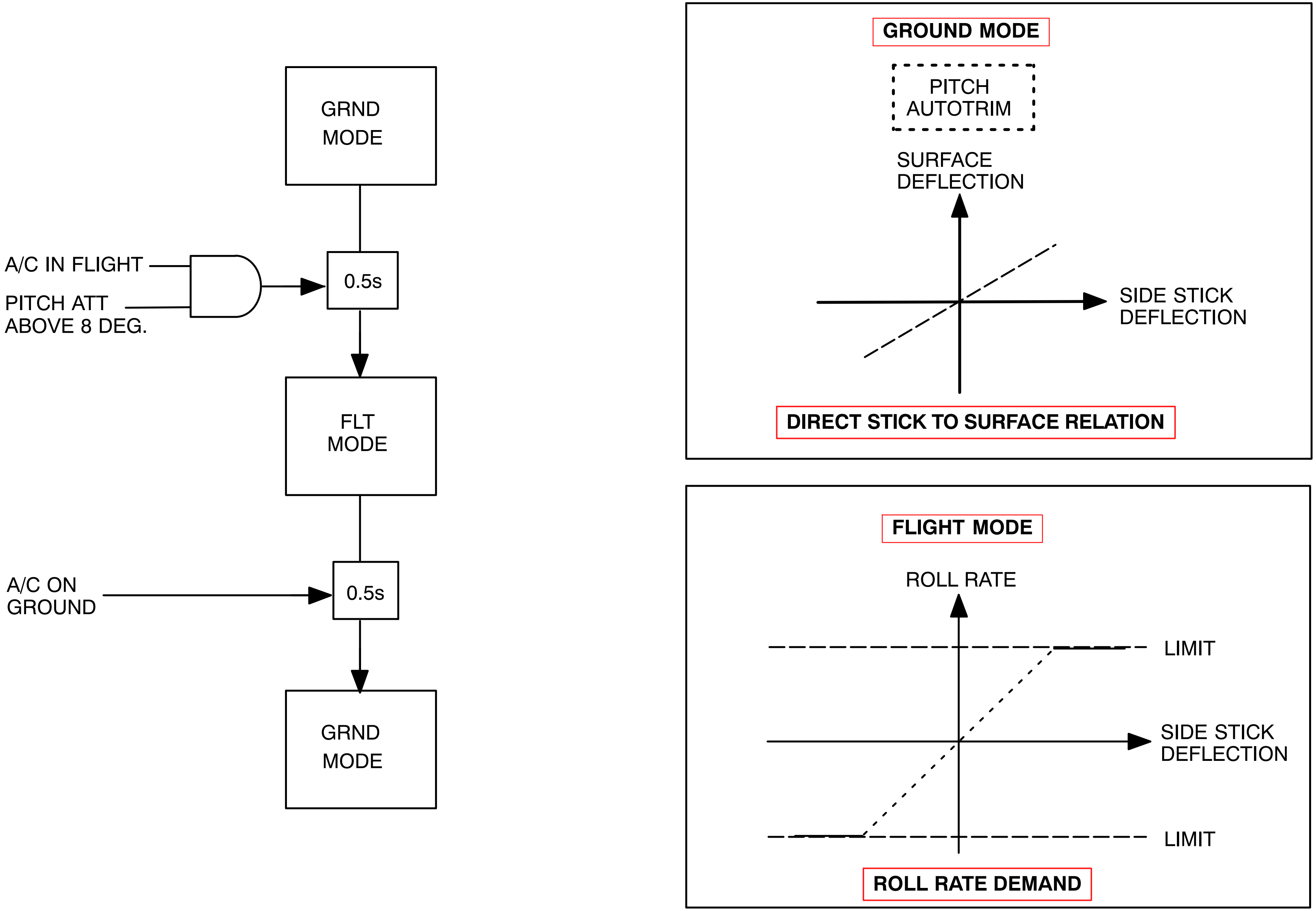


Figure 20 Roll Normal Law

PROTECTIONS ROLL NORMAL LAW (FLT. MODE)

Bank Angle Protection

Bank angle protection keeps roll rate and bank angle to the limits given by the flight manual.

Inside the normal flight envelope, positive spiral stability is introduced above 33° bank angle. If the side stick is released with a bank angle greater than 33°, the bank angle reduced automatically close to 33° or below.

Up to 33° bank angle, the roll attitude is held constant with the stick in at neutral

If full stick deflection is maintained, the bank angle is limited to 67° (indicated by green symbols " = " on PFD).

If angle of attack protection or high speed protection is operative, the bank angle is limited to 45° .

Yaw Damping

A yaw damper is provided to damp dutch roll.

It is active in roll normal law.

Turn Coordination

Turn coordination is active in roll normal law only.

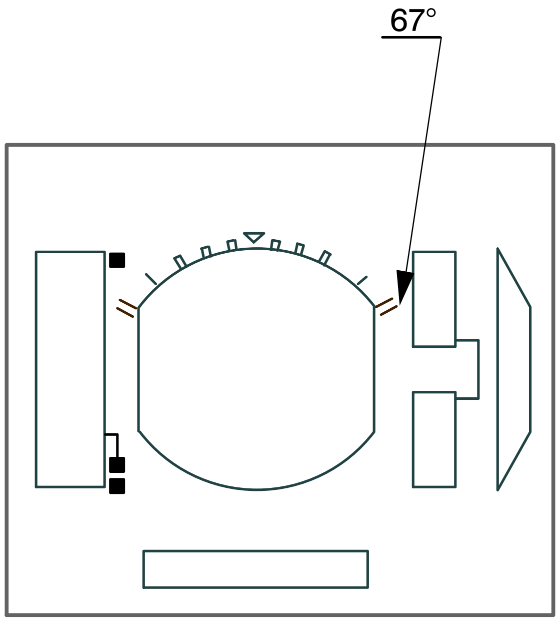


Figure 21 PFD – Roll Normal Law Protection

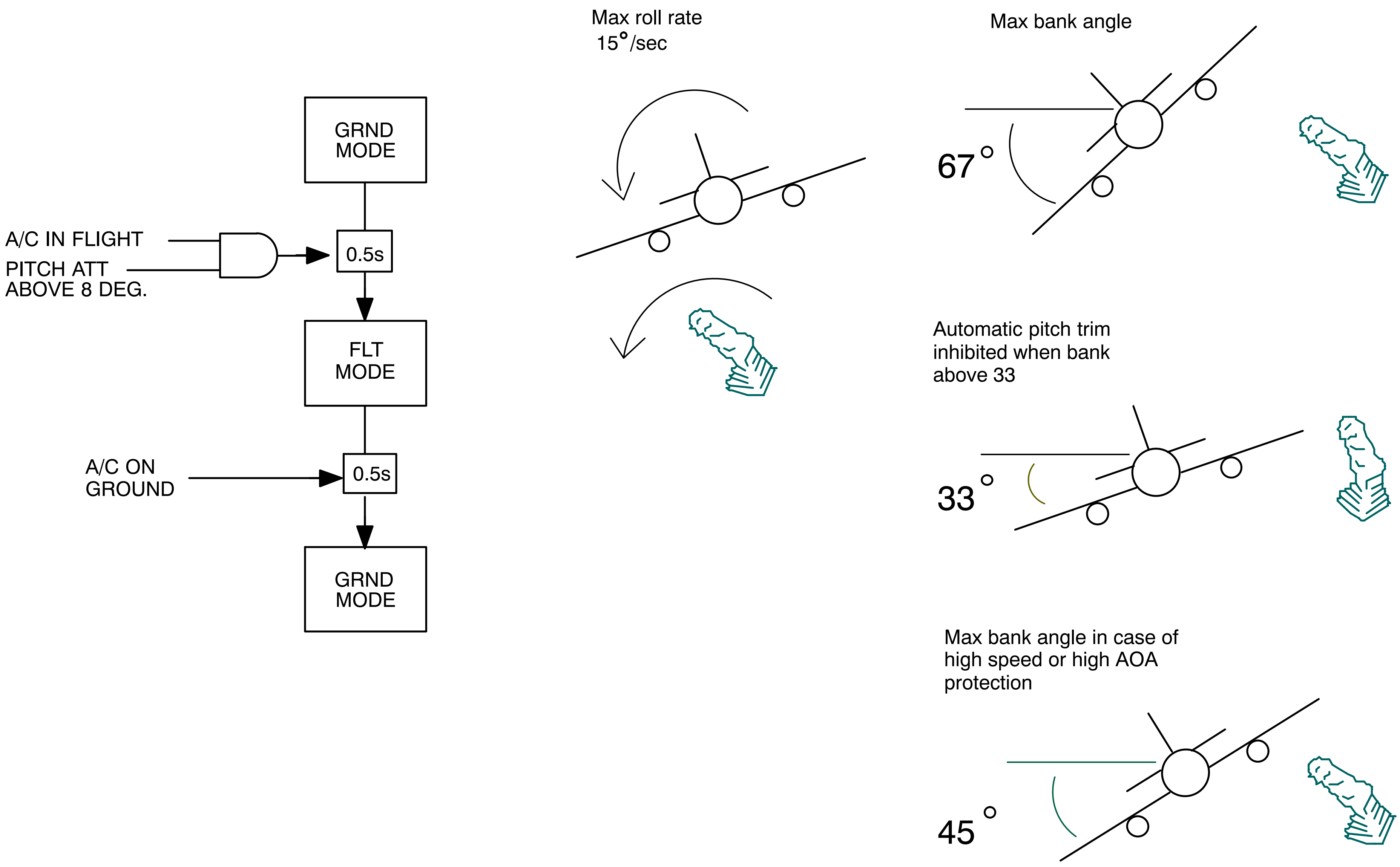


Figure 22 Roll Normal Law Protection

ROLL DIRECT LAW (ALTERNATE YAW)

Roll direct Law

The roll direct law provides a direct stick to surface position relationship. Turn coordination is lost, the rudder is operated by the pedals.

The gains are automatically set according to slat/flap configuration.

In clean configuration, the maximum roll rate is about 30°/sec.

In slats extended configuration , it is about 25°/sec.

To limit the roll rate, the roll direct law uses only ailerons and spoilers 4 and 5. If spoiler 4 has failed it is replaced by spoiler 3.

If the ailerons have failed, all roll spoilers become active.

Overrideable limitation symbols are displayed amber on the PFD.

The bottom of the speed scale is red.

Alternate Yaw Damping

In roll direct law, alternate yaw damping is active. Damper authority on the rudder is limited to ± 5°.

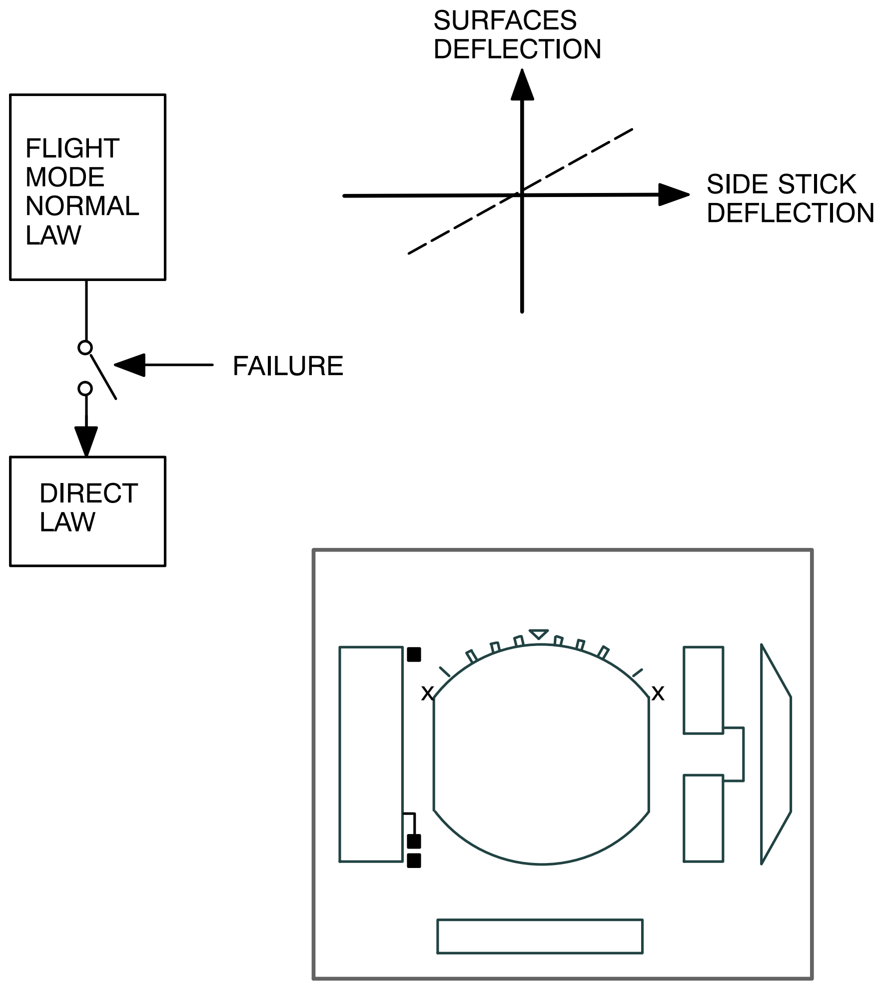


Figure 23 Electric Flight Control Laws

This diagram summarizes the roll reconfiguration

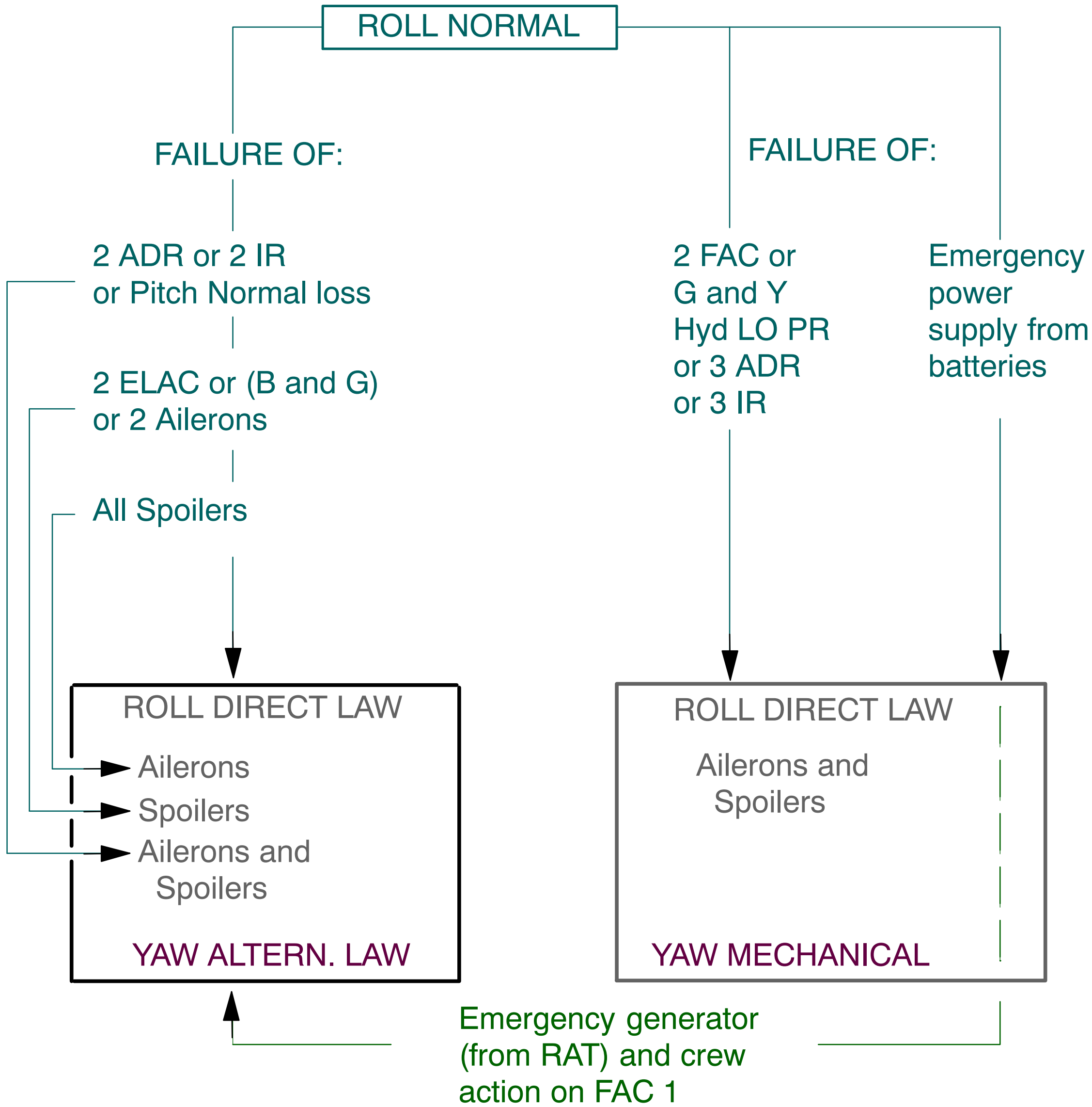


Figure 24 Control Law Reconfiguration

27–93 ELAC SYSTEM

ELEVATOR AILERON COMPUTER (ELAC) COMPONENT DESCRIPTION

General

The two ELACs are in charge to control the Elevators, the Ailerons and the position of the THS (**T**rimable **H**orizontal **S**tabilizer).

The two ELAC units are located in the avionic compartment on panel 80VU. The ELAC case is of the ARINC 6OO standard. The computers are made by Thomson and are based on MOTOROLA 68000 microprocessors. As the SECs are used as back–up for the ELACs, these computers are for safety reasons developed and produced by another vendor, Sextant, and the microprocessors are based on INTEL 80186 technology.

The computer consist of 10 electronic boards which are plugged in from the front of the unit when opened. The COM unit consist of five boards and the MON unit also five boards, separated by a centre partition. Each computer has its own power supply located at the longitudinal mid plane.

The ten internal boards are as follows, in the MON unit:

- MAN: Monitoring Analog Board
- MPU: Monitor Processing Board
- MDG: Monitor Digital Board
- MSP: Monitor Slave Processing Board
- MPS: Monitor Power Supply

In the COM unit:

- CPS: Command Power Supply
- CDG: Command Digital Board
- CPU: Command Processing Board
- CAN: Command Analog Board
- CPS: Command Slave Processing Board

Power Up Test

The power–up test is initiated when power is applied. After test is passed the ”F/CTL” page will display ”ELAC” in green.

During the test the ECAM ”F/CTL” page will display ”ELAC” in amber and aileron servo control amber boxed. The ”FAULT” legend in the ELAC switch will illuminate for a specific time (depending on A/C condition).

ECAM warning:

- F/CTL ELAC 1 (2) FAULT

Power–up and Pressure–up tests are performed without surface movement.

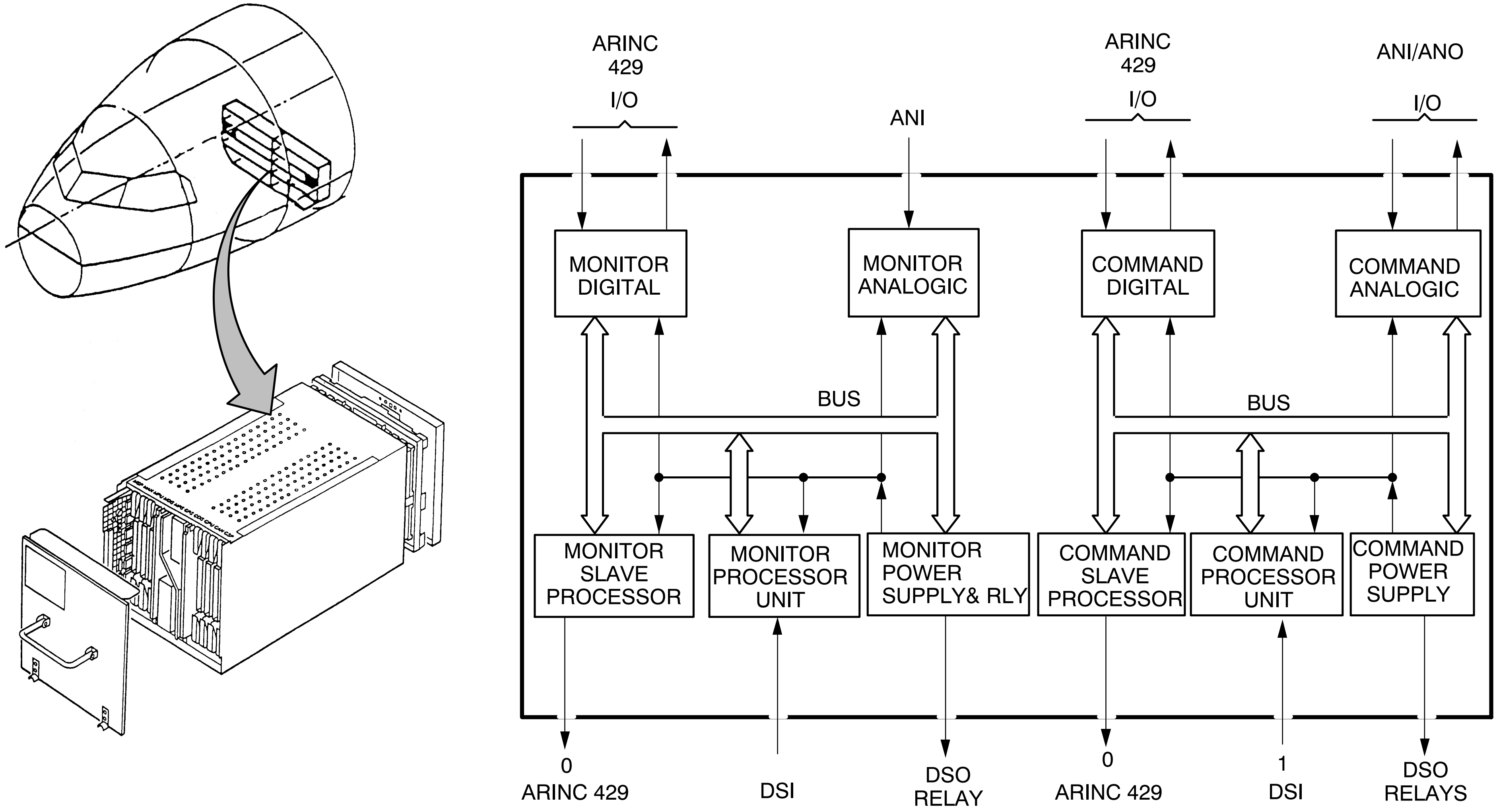


Figure 25 ELAC Internal Boards

ELAC INTERFACES

The two ELACs receive a number of inputs, digital as well as discrete or analogues from various aircraft systems. The inputs are distributed to both the COM and to the MON section in both computers.

The computers COM and MON sections will all calculate a output, transmitted via the safety relays to the servo control units, provided the individual computer COM and MON sections agree in the calculated outputs

The ELACs will both perform the calculations, and the stand−by unit will thus be ready for take−over with calculated signal when required.

The ELAC output is transmitted to the Aileron servo actuators for roll command and to the Elevator servos for Pitch command and to the THS for Pitch trim.

The ELAC outputs are in addition send to the FACs for automatic turn coordination, to the SEC's for automatic roll spoilers and to the FCDC's for indications and CFDS access.

The COM unit of the ELACs performs two main functions:

- slaving proper with elaboration of the servo valve current.
- monitoring of the generated current through re−reading of the servo valve current.

The MON unit has the two main functions:

- comparison between the deviation signal of the MON channel and the servo valve current received from the COM unit.
- comparison between aileron position and the order elaborated in the MON. The monitoring function are passive when the LAF becomes active.

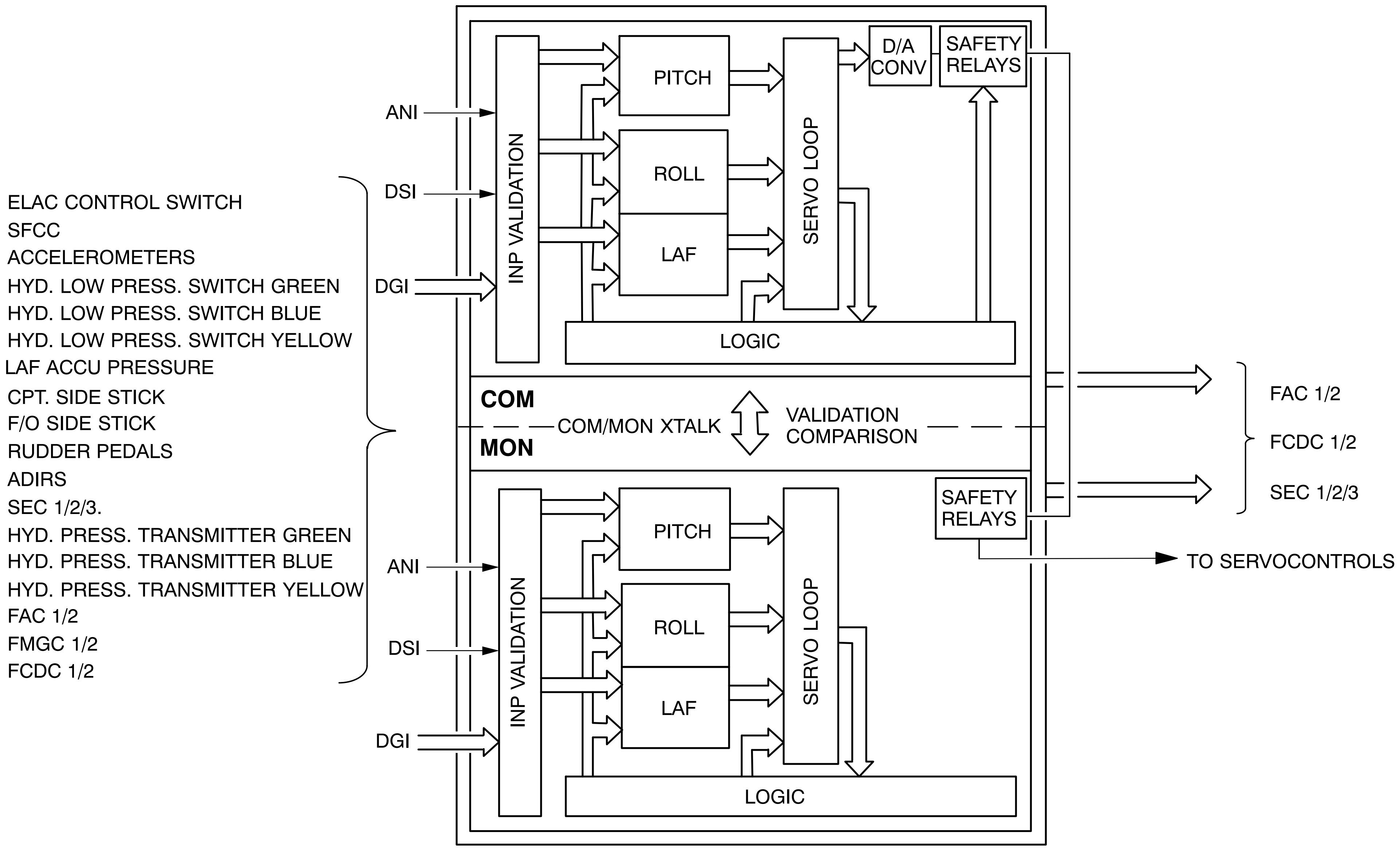


Figure 26 ELAC Interfaces

27–60 SPOILER

SPEEDBRAKES SYSTEM DESCRIPTION

Speed Brakes Control

The speed brakes are controlled by the speed brake lever and achieved by the spoilers 2, 3 and 4.

The surface deflection is depend on the speed brake lever position up to maximum 40° for panel 3 and 4, max. 20° for panel 2.

On A321 all surfaces deflect to max. 40°.

Speed brake extension is inhibited in following cases:

- SEC 1 and 3 fault
- Elevator L or R fault (in this case only SPLR 3 & 4 are inhibited)
- Angle of attack protection is active
- In FLAPS FULL configuration (A318/319/320) or FLAPS 3 position (A321)

If speed brakes are extended, they automatically retract and kept retracted until inhibition condition disappears and lever reset.

When one surface is failed on one wing, the symmetric one on the other wing is inhibited.

For surfaces 2, 3 and 4 which perform roll and speed brake functions, the roll function has priority:

- When the sum of a roll order and a simultaneous speed brake order on surface is greater than the maximum deflection achievable in flight, the symmetrical one is retracted until the difference between the two surfaces is equal to the roll order.

  The position of all surfaces is indicated on the lower ECAM display unit via the Flight Control Data Concentrators
  - Flight Control Page
  - Wheel Page (ground spoilers)

Speed Brake Control Transducer Unit

The speedbrake control is achieved through a specific unit located on the aft left part of the center pedestal.

This unit is also used for ground spoiler function–preselection.

The control lever zero position is locked in maximum forward position and the lever is moved in aft direction to extend speedbrakes.

it is necessary to push the handle to move the lever out of the zero position.

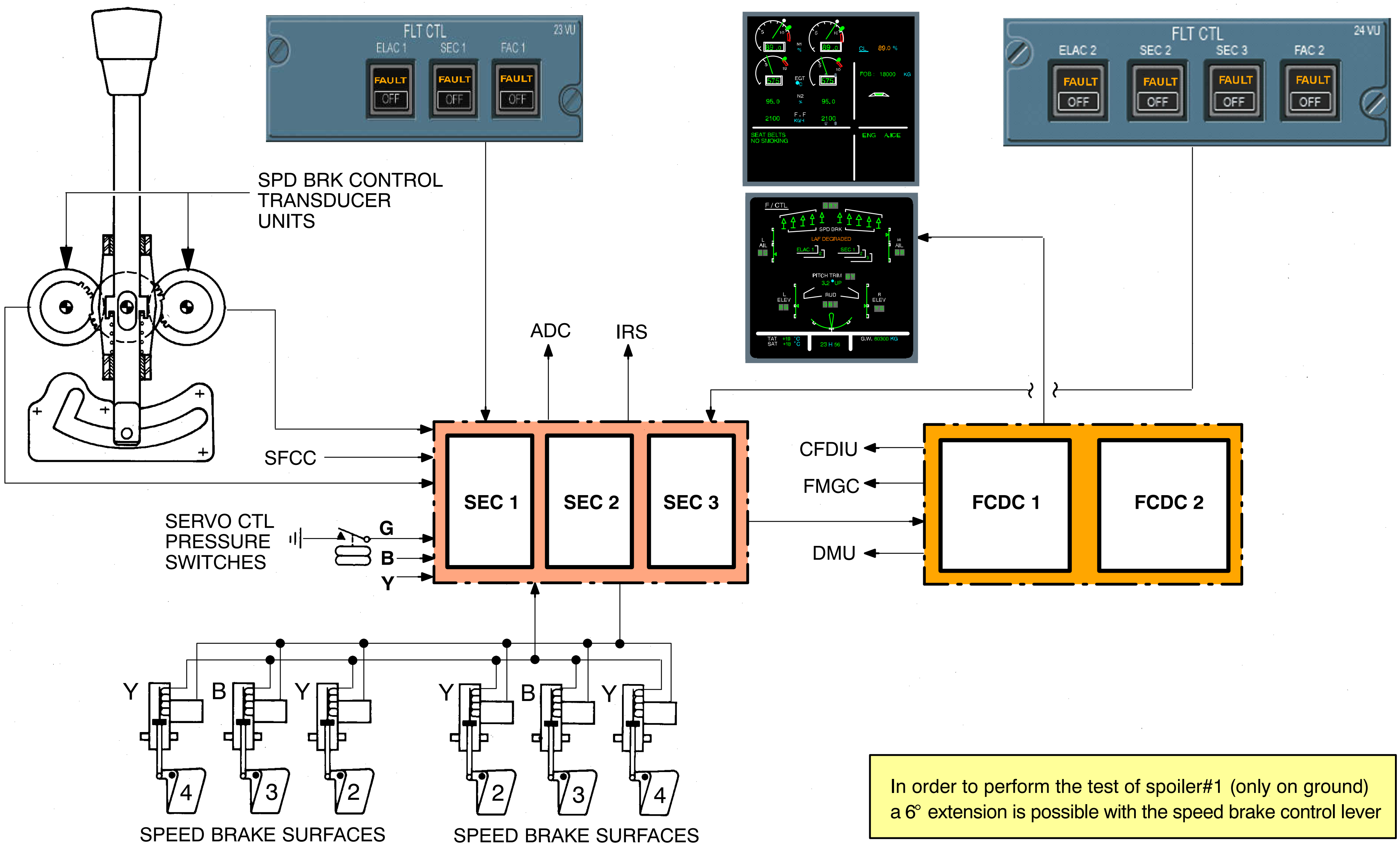
Ground spoiler preselection is achieved from zero position by pulling the handle (a slight lever forward position is then induced due to the special mechanical design).

The input lever drives one end of a axis which has a friction brake at the other end to provide an artificial feel and to freeze the lever position when it is out of the zero selection.

A duplicate system is used to drive two sets of potentiometers.

The mechanical design is such that a single mechanical failure is not able to cause simultaneous loss of the two potentiometer drives or to disconnect input lever and to forbid in the same time the brake to freeze the position.

- The COM unit of each SEC computer is connected to one potentiometer of one set, the MON unit being connected to a potentiometer of the other set.



In order to perform the test of spoiler#1 (only on ground) a 6° extension is possible with the speed brake control lever

Figure 27 Speed Brake Schematic

GROUND SPOILER CONTROL DESCRIPTION

The ground spoiler control is entirely automatic. Achieved by the spoilers 1 to 5. The maximum deflection is 50° with a deflection rate of 30°/sec.

The Ground Spoilers are armed :

- when the speedbrake control lever is pulled up into the ARMED position.

Ground Spoilers automatically extend (when armed):

- both thrust levers at forward idle and both MLG touch down (Flight/Ground Transition)

  OR
- during TO run at speed greater than 72kts and both thrust levers retarded at forward idle

Ground Spoilers automatically extend (not armed):

- when both MLG touch down and reverse is selected on at least one engine (remaining engine at idle)

  OR
- during TO run at speed greater than 72kts and reverse is selected on at least one engine (remaining engine at idle).

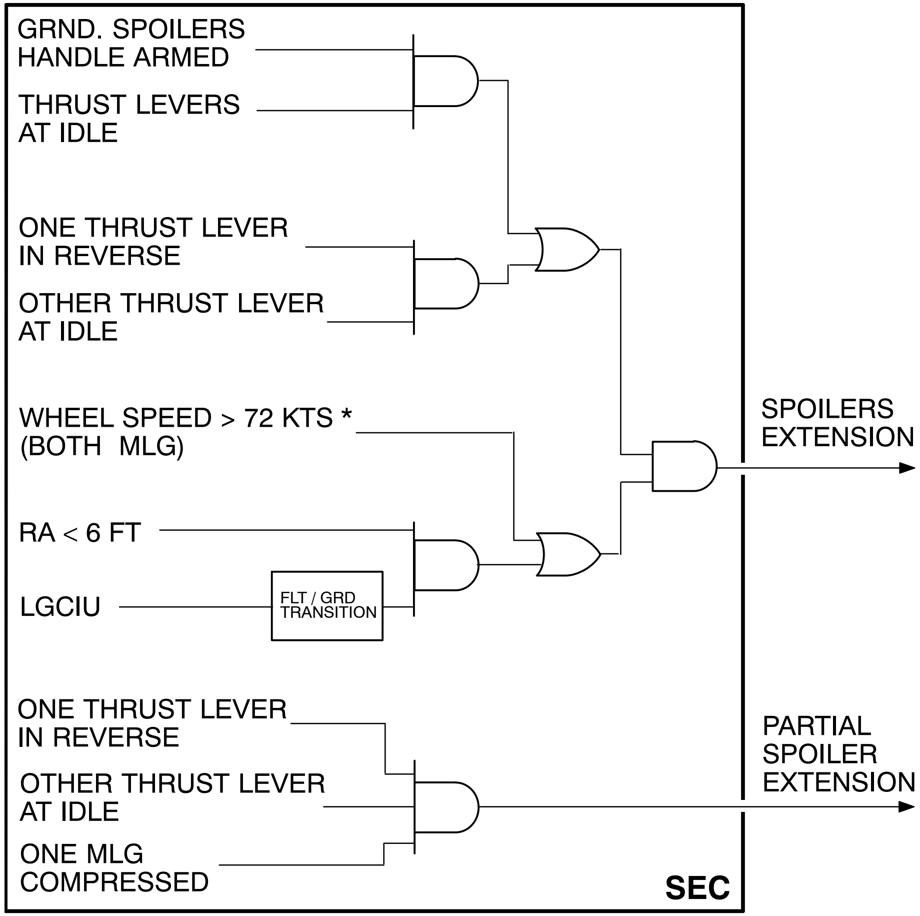
Ground Spoilers partially extend:

- when reverse is selected on at least one engine (remaining engine at idle) and one MLG is compressed.

  This partial extension (10°), by decreasing the lift, will ease the compression of the second MLG, and consequently will lead to the normal ground spoiler extension.

Note:

- The speed brake handle will not move during spoiler deflection or retraction.
- The spoiler position will be displayed on the lower ECAM display WHEEL PAGE



* Condition on wheel speed is inhibited after FLT/GRD transition
The condition is rearmed if wheel rotation stops
Consequently after an a/c bounce (a/c airborne)
- the spoilers remain extended with thrust levers at idle
- the spoilers retract if thrust is increased above idle, and extend again after the next touch down.

Figure 28 Ground Spoiler Extension

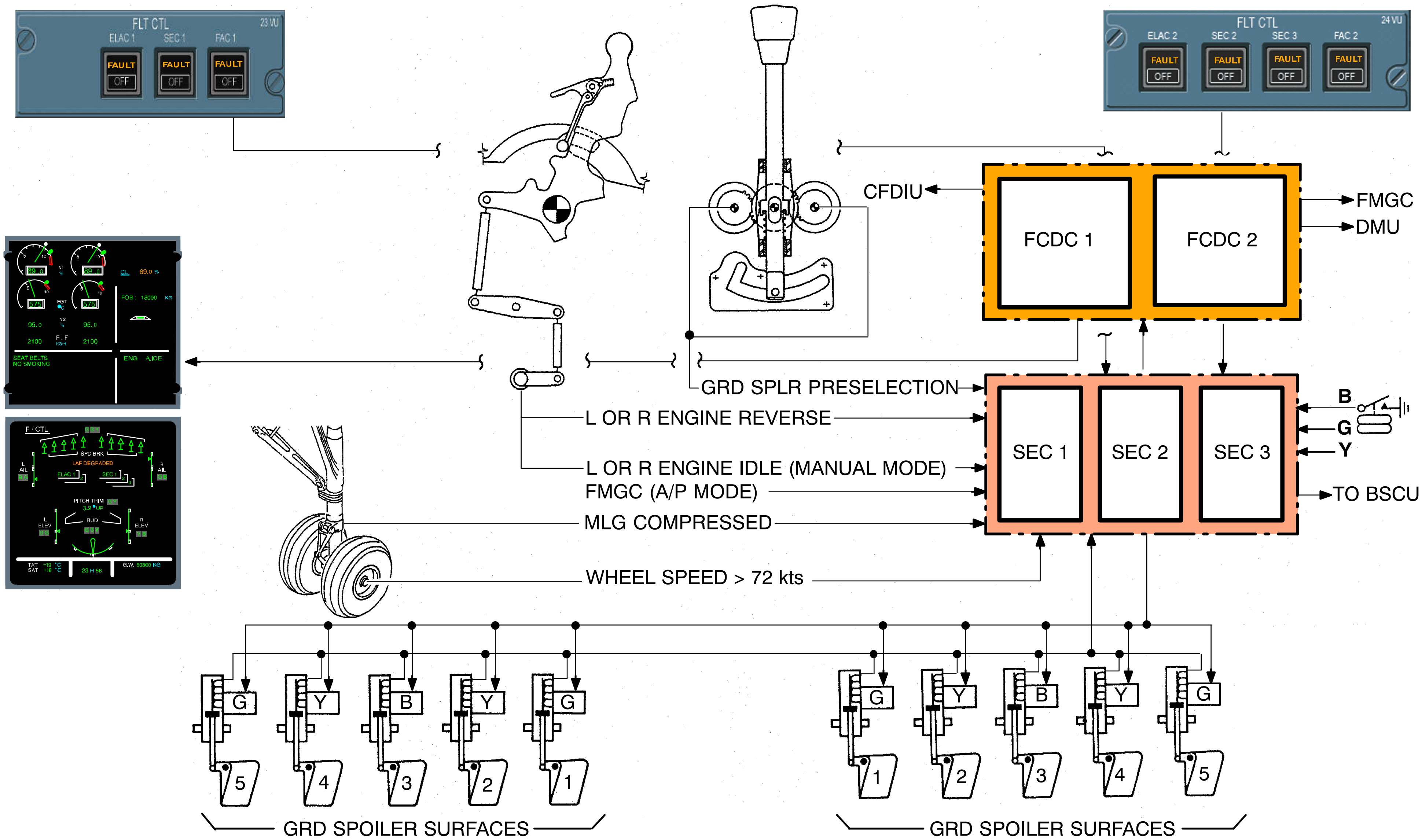


Figure 29 Ground Spoiler Schematic

SPOILER SCU COMPONENT DESCRIPTION

Spoiler Servocontrol

On A320 there are two types of servocontrols with different overall dimensions:

- 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 Load Alleviation Function (on A318/319/A321 the inboard type is used for all spoiler surfaces).

The spoiler actuators can operate in:

- Active mode
- Biased mode.
- Locked mode.

In Active mode the spoiler actuator is hydraulically supplied. The SEC will signal the servo valve and the spoiler panel will extend or retract according to the input. The LVDT in the actuator piston will provide position feedback to the SEC.

Pressure is applied to the by−pass valve (3) and to the plunger (7) which holds the closing valve (6). The two actuator chambers are connected to the servo valve control lines.

Biased mode becomes active if the electrical control signal is lost. The servo actuator is 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(6) 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.

MEL and Deactivation

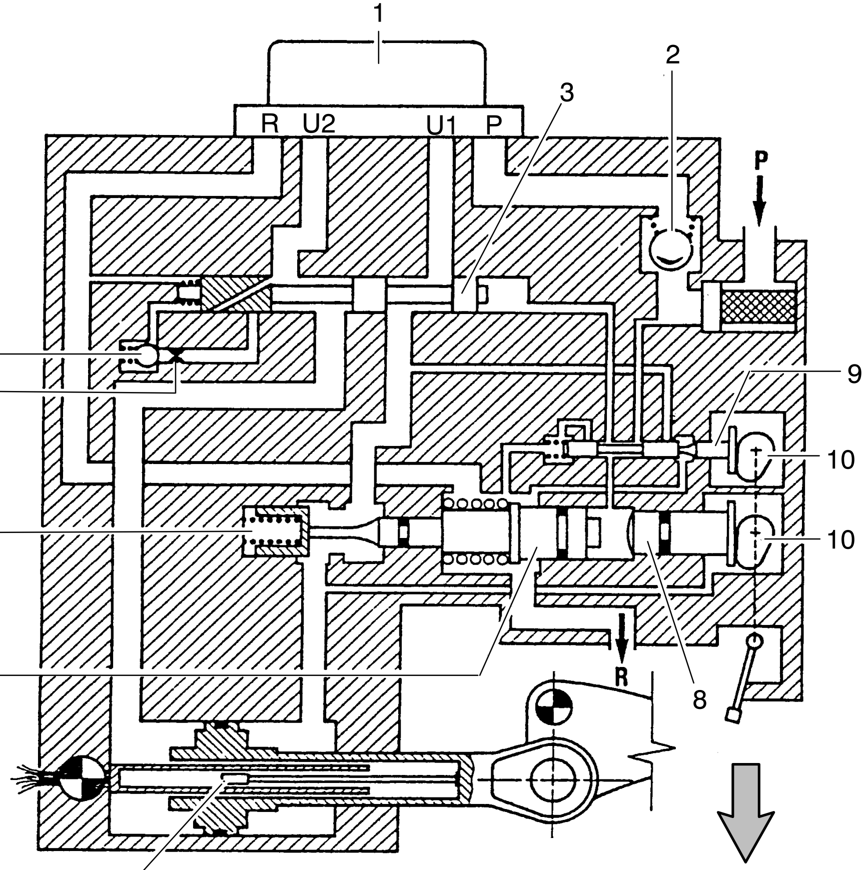
The spoiler servocontrol is a MMEL item. To deactivate the spoiler servocontrol, disconnect the electrical connector from the receptacle of the servocontrol.

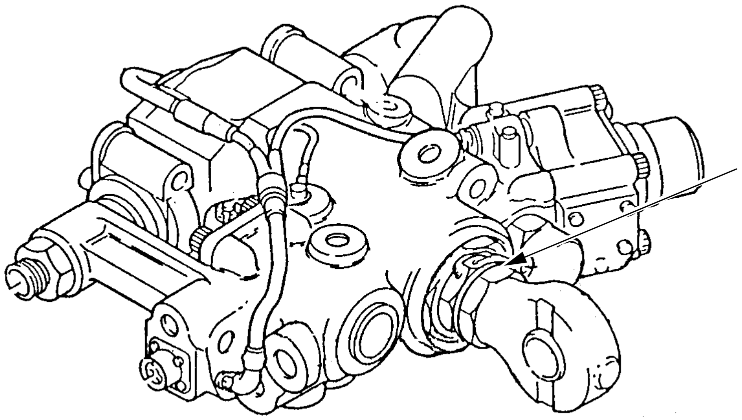
When you deactivate a spoiler servocontrol, you must also deactivate the symmetrical servocontrol on the other wing.

The detailed procedure is given in the AMM.

ELECTRICAL CONNECTOR

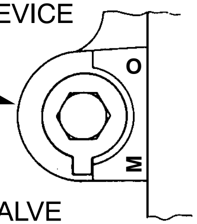
MAINTENANCE UNLOCKING DEVICE (NEW VERSION)





ROD EYE ADJUST

MAINTENANCE UNLOCKING DEVICE (OLD VERSION)



1. SERVOVALVE
2. CHECK VALVE
3. BY-PASS VALVE
4. CALIBRATED VALVE
5. ANTI CAVITATION VALVE
6. CLOSING VALVE
7. PLUNGER
8. PRESSURE INCREASING VALVE
9. MAINTENANCE PRESS. INHIBITING VALVE
10. MAINTENANCE UNLOCKING CRANK LEVER
11. FEEDBACK TRANSDUCER (LVDT)

Figure 30 Spoiler SCU

LOAD ALLEVIATION SYSTEM FUNCTION AND ACCELEROMETERS

General

The load alleviation function (LAF) permits to alleviate the loads imposed on the wings upon gust application. This is done through the simultaneous upward deflection of the two ailerons and of the spoilers 4 and 5 at very high rate (200°/sec).

The LAF orders are added to those generated by other laws.

Note:

- The LAF system, with accumulators and special servo control units, is only installed on early A320 versions.
- On a/c equipped with sharklets LAF is active without special hardware and spoilers 4 and 5 may be operated independent from the ailerons.

Description

The load alleviation function, which operates through the ailerons and spoilers 4 and 5, becomes active only in condition of turbulence in order to relief wing structure loads.

The high hydraulic demands required to archive the rapid surface movements are provided with the help of dedicated accumulators.

The LAF becomes active when the difference between a/c load factor and pilot demanded load factor exceeds 0.3 g in which case:

- the ailerons are deflected symmetrically upwards (order computed by the ELACs)
  - Maximum 10° added to roll demand, if any.
- the spoilers 4 and 5 are deflected symmetrically (order computed by the SECs)
  - Maximum 25° added to roll demand, if any.

The load alleviation function is inhibited with:

- FLAPS lever not in 0 position.
- Speed below 200 kts.
- Slats/Flaps wing tip brake engaged.
- Pitch direct law.
- Pin programming

Accelerometers

Vertical acceleration values are needed for pitch control laws and also for Load Alleviation Function.

Four specific accelerometers are fitted in the fuselage (FWD cargo compartment) for this purpose.

- each of them receives 28 V DC and delivers on four separate outputs an analog signal representative of the vertical acceleration referenced to the aircraft body.
- each output is connected to a COM or MON unit of ELAC or SEC.

Note:

- Since the accelerometers are also used for pitch control laws they are still installed even if the a/c is not equipped with the LAF function.

LAF Accumulators

The high hydraulic fluid demand required to achieve the rapid spoiler panel movement are provided by four hydraulic accumulators located in the wing trailing edge close to the spoiler panels.

The accumulator is a cylindrical type with an internal rubber bladder.

The accumulator has a total volume of 1ltr and the gas precharge pressure is 130 bar (1885 psi)

A pressure transducer monitors the accumulator pressure. The pressure signal is send to the FCDCs, in case of low pressure a ”LAF DEGRADED” message will be displayed on the ECAM F/CTL page.

LAF Degraded Law

If the LAF NORMAL LAW can not be achieved, a DEGRADED LAW is provided.

Depending on failures or failure combinations (e.g. servo, computer, accumulator failures) the surface deflection rate and the deflection angle may be changed and a “LAF DEGRADED“ message may be displayed.

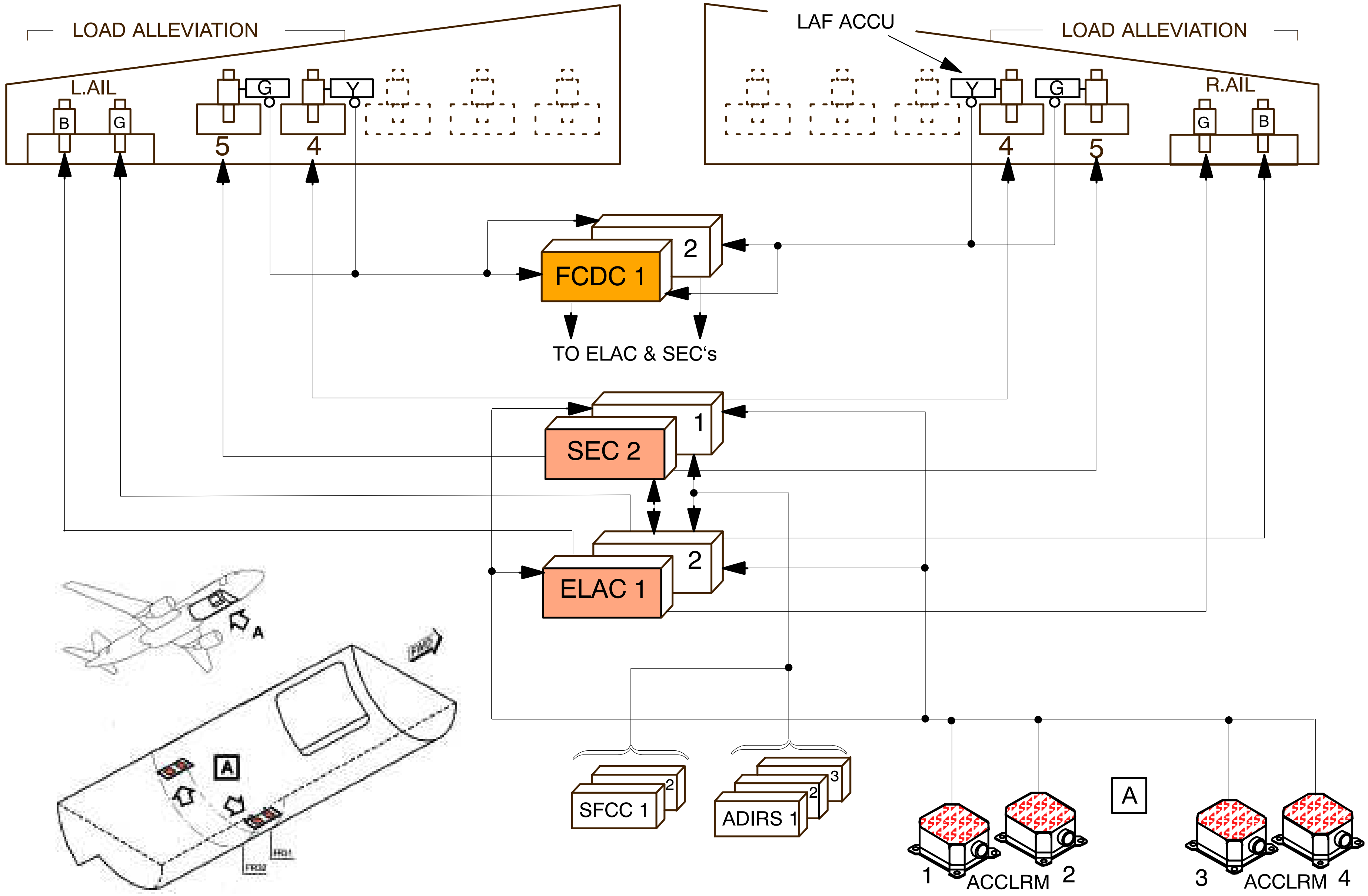


Figure 31 LAF Schematic

27−94 SEC SYSTEM

SPOILER ELEVATOR COMPUTER (SEC) COMPONENT DESCRIPTION

General

The three SECs are located in the avionic compartment. Number 1 and 2 at panel 83VU and 84VU and number 3 at panel 93VU.

The SECs are equal and interchangeable. The computer will know its installation position by pin programming and will know which surfaces it is controlling.

The three SECs are controlled by switches on the overhead flight control panel. SEC 1 on the left and SEC 2 and 3 on the right hand side. When the SEC is active the light in the switch will be extinguished.

The SECs are manufactured by Sextant in France and is organized around two channels, one command and one monitor channel using INTEL 80186 microprocessors.

The command channel receives analog sensor data, ARINC data and discrete signals and uses them to calculate the commands used to drive the corresponding servo valve. The connection between the computer and the servo valve is analog signal.

The monitor channel receives independently transducer data required to compute the control laws. The MON section will monitor the computations from the com channel and in particular the servo loop.

Data are exchanged between the two channels in order to perform consolidation and synchronization. A high−speed ARINC bus is used for this purpose.

The com and the MON channels each performs five main functions:

- input management
- control law computation and synchronization
- servo loop processing
- engage logic
- output management

Output to the Elevators and the THS is through mon relays in series with the com relays.

The output to the spoiler servos are transmitted from the com through com relays for which the power supply and activation commands are generated by the MON channel.

Input to the SEC's are from the sidestick or from the FMGS. The roll spoiler signal is received from the ELAC's.

Power Up Test

Power−up test is performed when the SEC PB switch is activated or when power is applied. The "FAULT" legend in the switch will be illuminated for a specific time.

The ECAM. F/CTL page will indicate SEC 1−2−3 in amber and associated elevators and spoiler legends will be crossed amber during the power up test.

ECAM warning:

- F/CTL SEC 1 (2) (3) FAULT during 23sec approx.

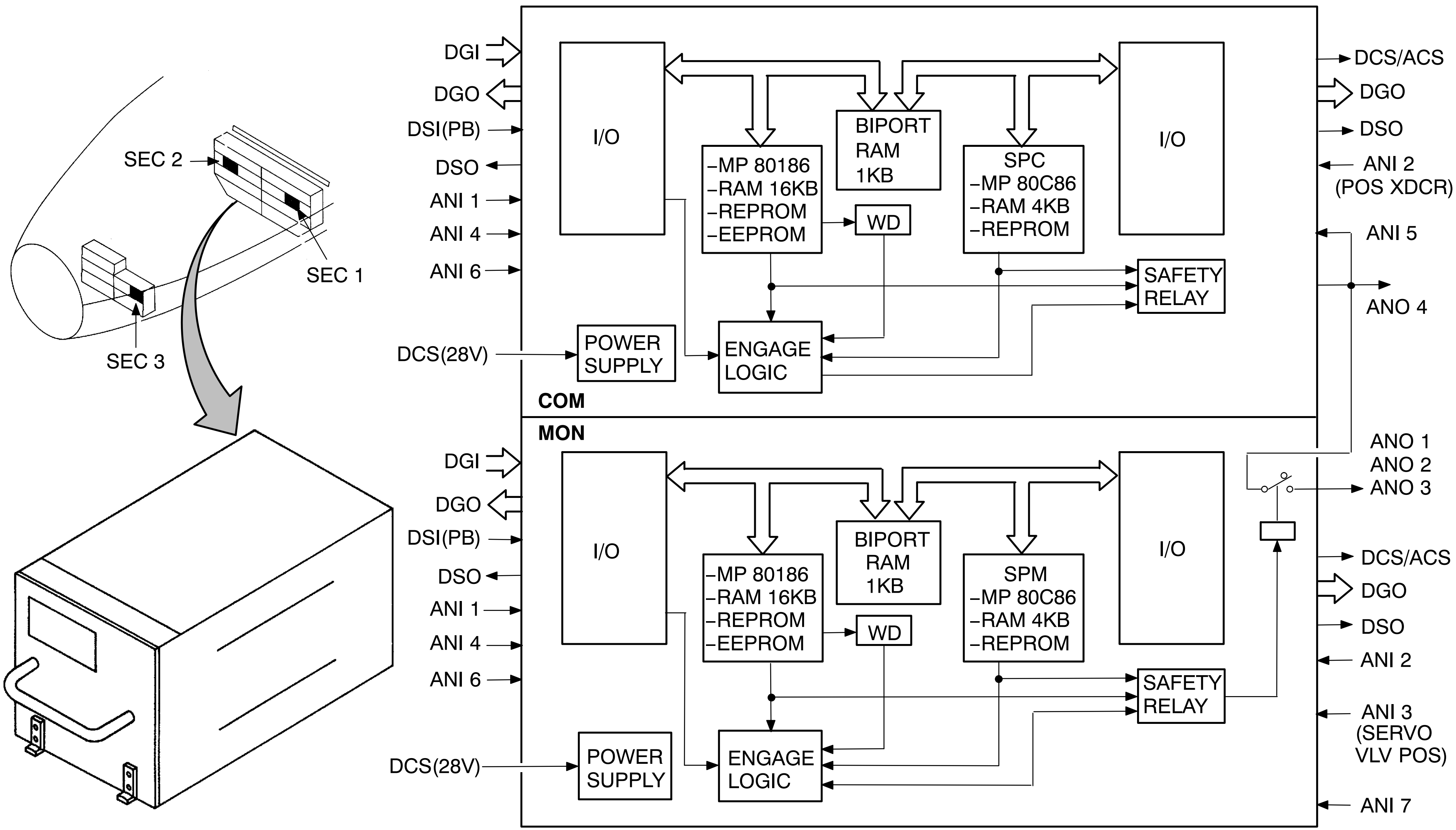


Figure 32 SEC Internal Boards

27–20 RUDDER

RUDDER SYSTEM DESCRIPTION

Basic System Description

Yaw control is achieved by the single rudder surface hinged to the trailing edge of the vertical stabilizer. The maximum deflection is 30° left and right. The rudder is activated by three independent hydraulic servo actuators operating in parallel, using all three hydraulic systems as power source.

The rudder is controlled by the FAC (**F**light **A**ugmentation **C**omputer) 1 and 2. Number 1 normally in command, number 2 as back up. Input to the FACs are signalled from the FMGCs, the ELACs and from the rudder trim panel on the pedestal.

The FAC will calculate commands for Rudder Trim and Rudder Limitation. In addition the FAC will also calculate characteristic speeds displayed on the PFD (**P**rimary **F**light **D**isplay).

The electrical steering command calculated by the FAC is send to the two hydraulic operated Yaw Damper servo actuators, located in the lower part of the vertical stabilizer, one will be in active mode and the other at the same time in stand–by mode.

Turn co–ordination and yaw damping is calculated by the ELAC in command and transferred to the FAC for rudder command.

The turn co–ordination and yaw damping functions are available also in manual flight, with the FMGC in off line condition.

The rudder pedals are connected via a cable run directly to the servo actuator control valves, giving the pilots a possibility to take manual control of the rudder whenever required.

The left and right hand rudder pedal mechanism is connected by pushrods and is located under the cockpit floor.

The pedal movement will also activate two position transducer connected to ELAC 1 and 2. From the ELACs the signal is transmitted to the BSCU (**B**rake **S**teering **C**ontrol **U**nit), making it possible to steer up to 6° .

The mechanical input to the rudder servo control units is limited by the position of the Rudder TLU (**T**ravel **L**imitation **U**nit). The input rods will also act against the Artificial Feel & Trim Unit.

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.

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 reference mark is painted on the rudder and on the reference structure.

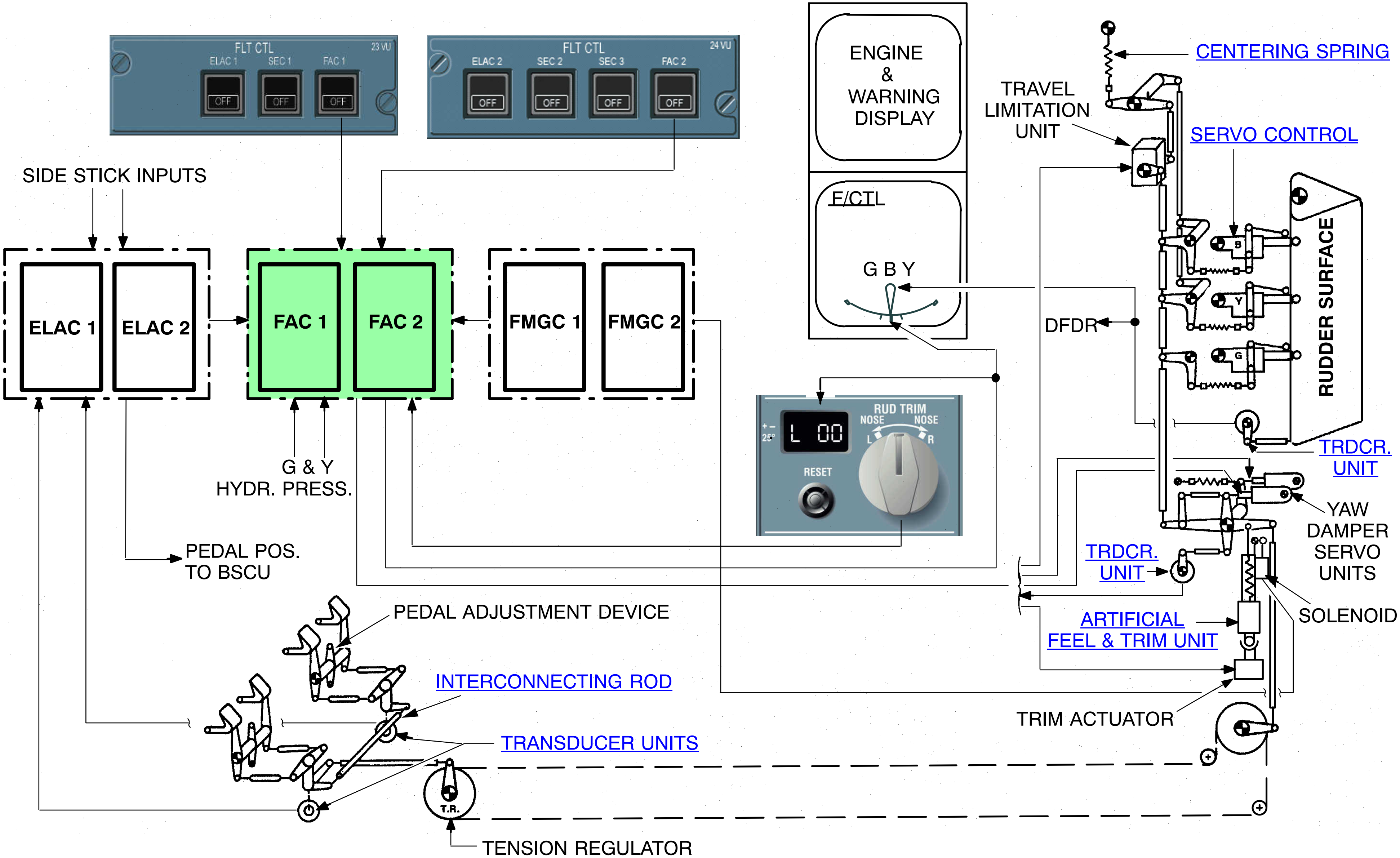


Figure 33 Rudder Control Schematic

27–21 RUDDER MECHANICAL CONTROL

CONTROL COMPONENTS DESCRIPTION

Rudder manual control is available at all times. The manual control is achieved by a cable run from the interconnected pedals directly to the differential mechanism.

Via pushrods the pedals are connected to a forward bellcrank under the cockpit floor.

- an adjuster which consist of a crank controlled screwjack is used to adjust the position of the pedal assembly.

The bellcrank contains a tension regulator, automatically compensating for thermal changes in the cable tension.

- it has a provision for the installation of a special tool used t install the regulator on the aircraft.

The single set of cables are routed under the cabin floor to the stabilizer compartment, to the aft pulley sector and further by pushrods to the differential mechanism.

Rigging holes are provided in the sectors, in the pedal mechanism and in the differential mechanism.

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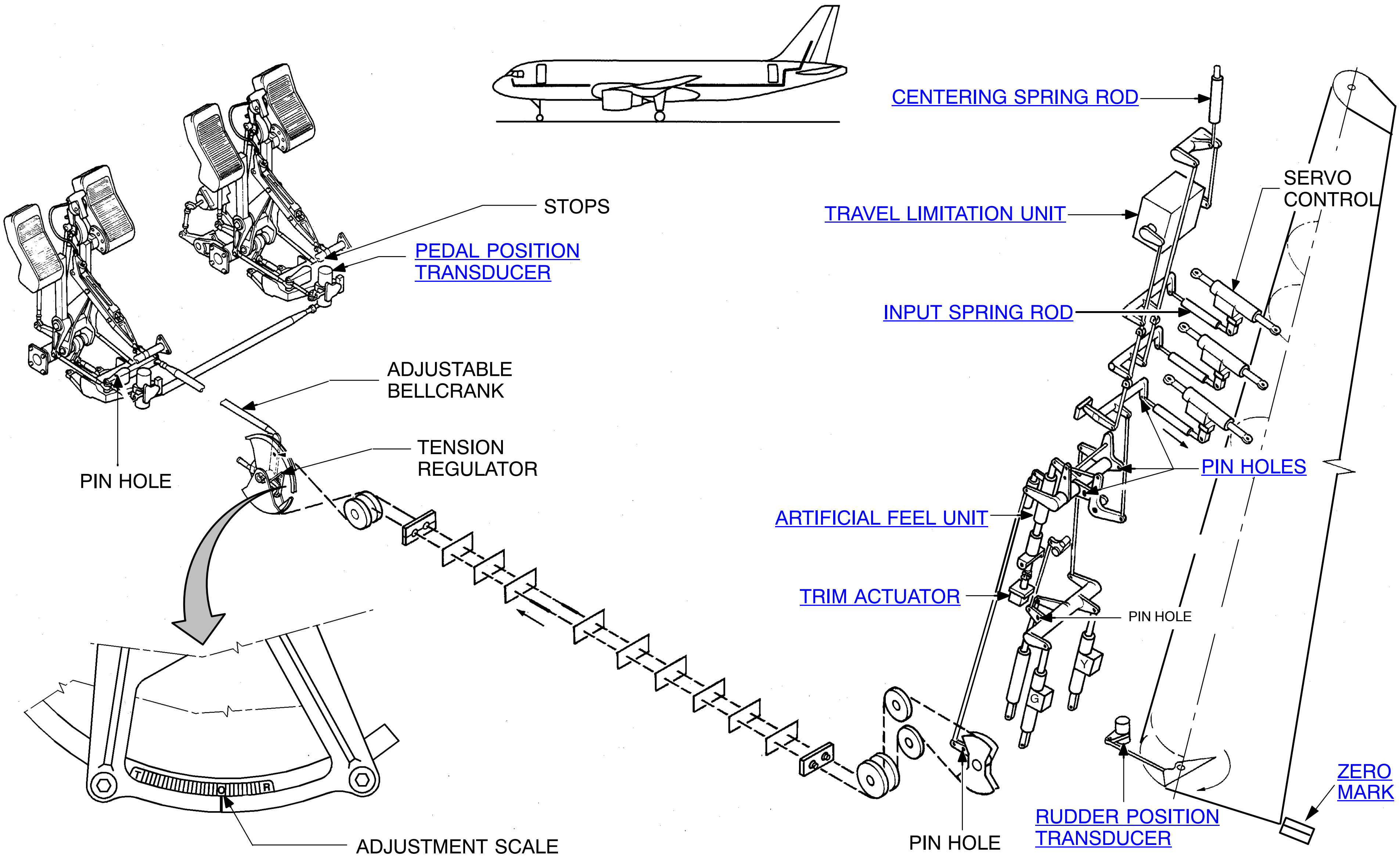


Figure 34 Rudder Mechanical Control

27−24 RUDDER HYDRAULIC ACTUATION

RUDDER SERVOCONTROL COMPONENT DESCRIPTION

The three servo actuators located in the trailing edge of the vertical stabilizer are equal and interchangeable. The actuators are all mechanical and does not contain any electrical connections.

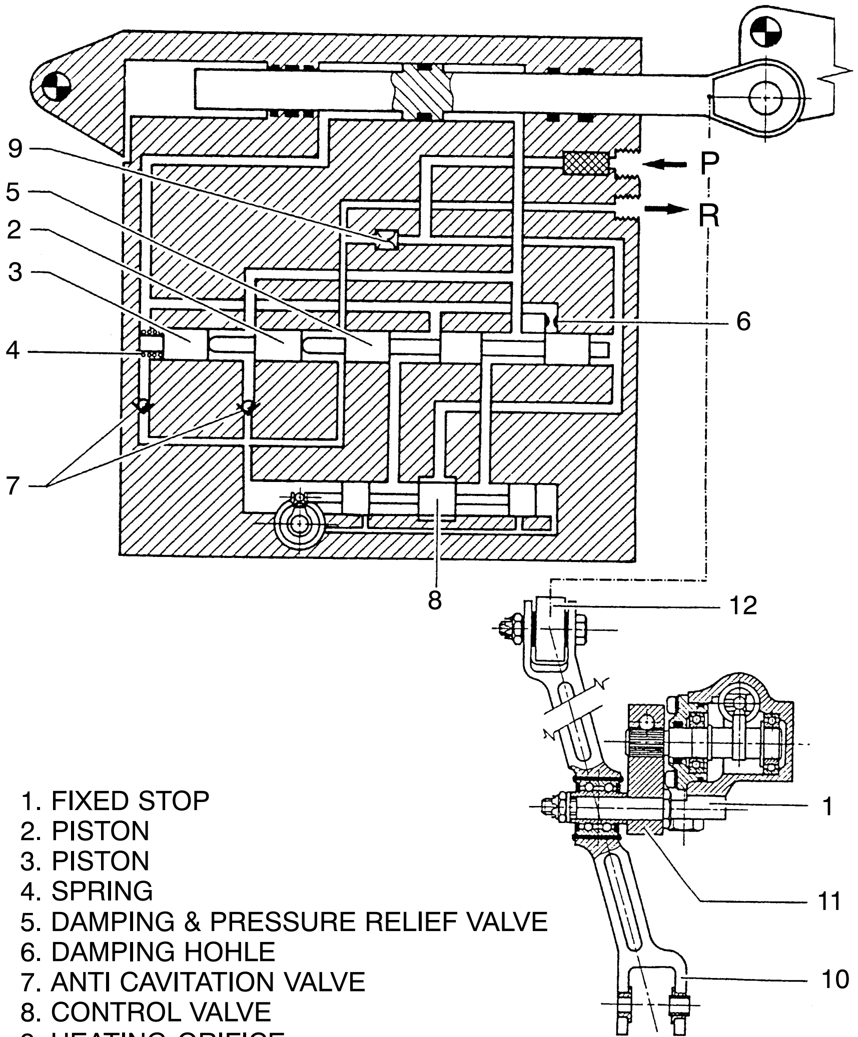
The input lever (10) is activated by the push rods connected to the differential mechanism receiving steering command from the pedals or from the yaw damper servo actuators, making all three servos operate simultaneously.

The input lever activates the control valve (8) causing the piston to change position. Movement of the unit will activate the feed−back rod (12) and the movement stops.

In case of pressure loss, the spring (4) position the damping and pressure relief valve to the by−pass position. This will permit the fluid to transfer between the chambers, passing the damping orifice. The remaining pressurized actuators will be able to control the surface.

With parked, unpressurized aircraft the relief valve will also be in by−pass position and providing damping for wind gusts up to 80 knots.

The two anti−cavitation valves (7) permits suction of hydraulic fluid to compensate for thermal retraction when in damping mode.



1. FIXED STOP
2. PISTON
3. PISTON
4. SPRING
5. DAMPING & PRESSURE RELIEF VALVE
6. DAMPING HOHLE
7. ANTI CAVITATION VALVE
8. CONTROL VALVE
9. HEATING ORIFICE
10. INPUT LEVER
11. ROTARY INPUT LEVER
12. FEEDBACK ROD

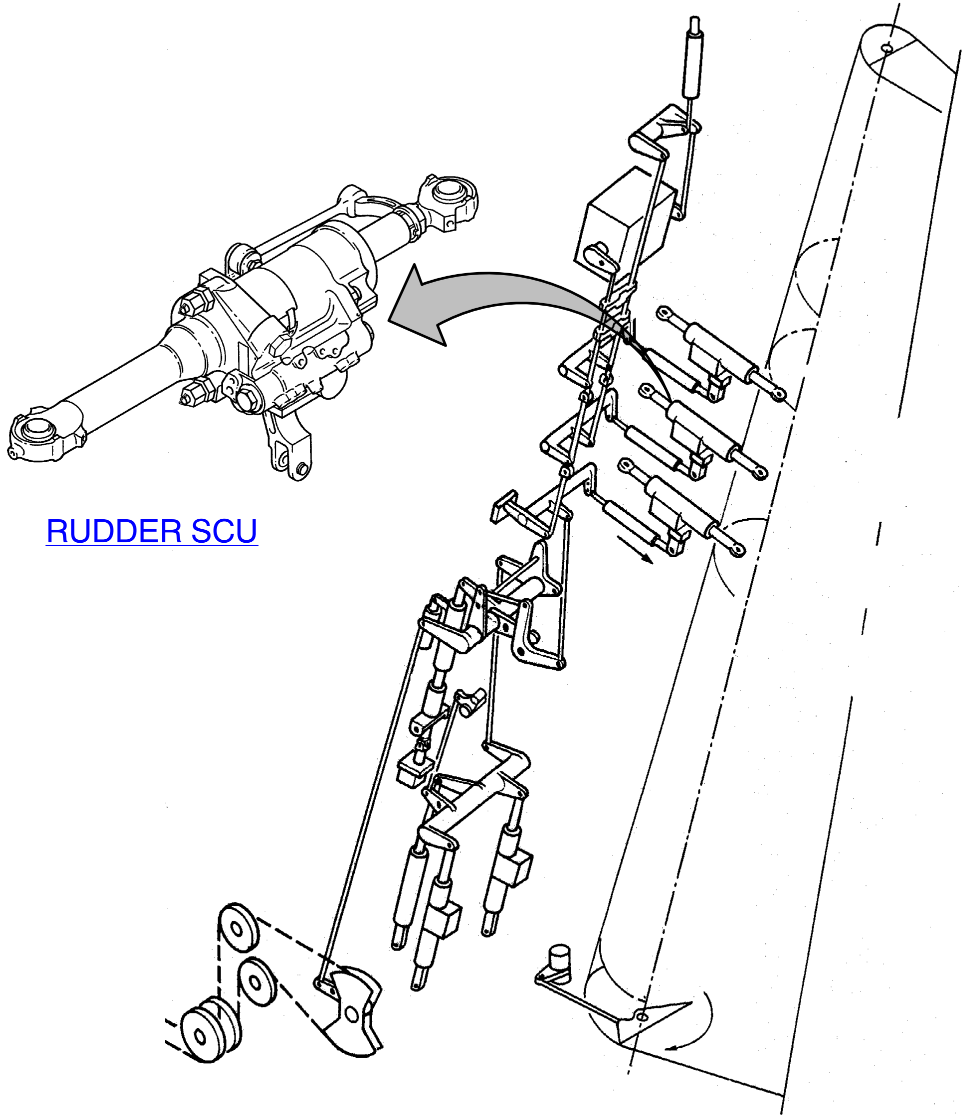


Figure 35 Rudder Servo Control

27–22 RUDDER TRIM ACTUATION

RUDDER TRIM SYSTEM OPERATION

The rudder trim is achieved by the electrical Rudder Trim Actuator via Artificial Feel and Trim unit located in the lower part of the vertical stabilizer.

The rudder trim unit activates the input pushrods to the rudder actuators and will provide the rudder with a new neutral position or ”anchoring point” when activated. The movement will also reposition the rudder pedals.

The trim actuator consist of two electrical motors. In normal operation FAC 1 with motor 1 are in charge with FAC 2 and motor 2 synchronized as back up.

The rudder trim actuator is controlled by the FACs and can operate in manual mode or automatic mode when the autopilot is engaged.

In manual mode the rudder trim panel on the center pedestal is used as input. Holding the switch will cause the rudder to move at a constant speed of 1°/sec up to 20° (25° on A318/319) left or right.

In automatic flight the automatic yaw trim is active. Rudder trim is calculated by the FAC and the FMGC. In case of engine failure, rudder trim is automatically applied.

The actual rudder trim actuator position is displayed in digital on the trim panel, in addition to the position on the F/CTL page.

A reset switch on the trim panel will cause the rudder to revert to neutral position when activated.

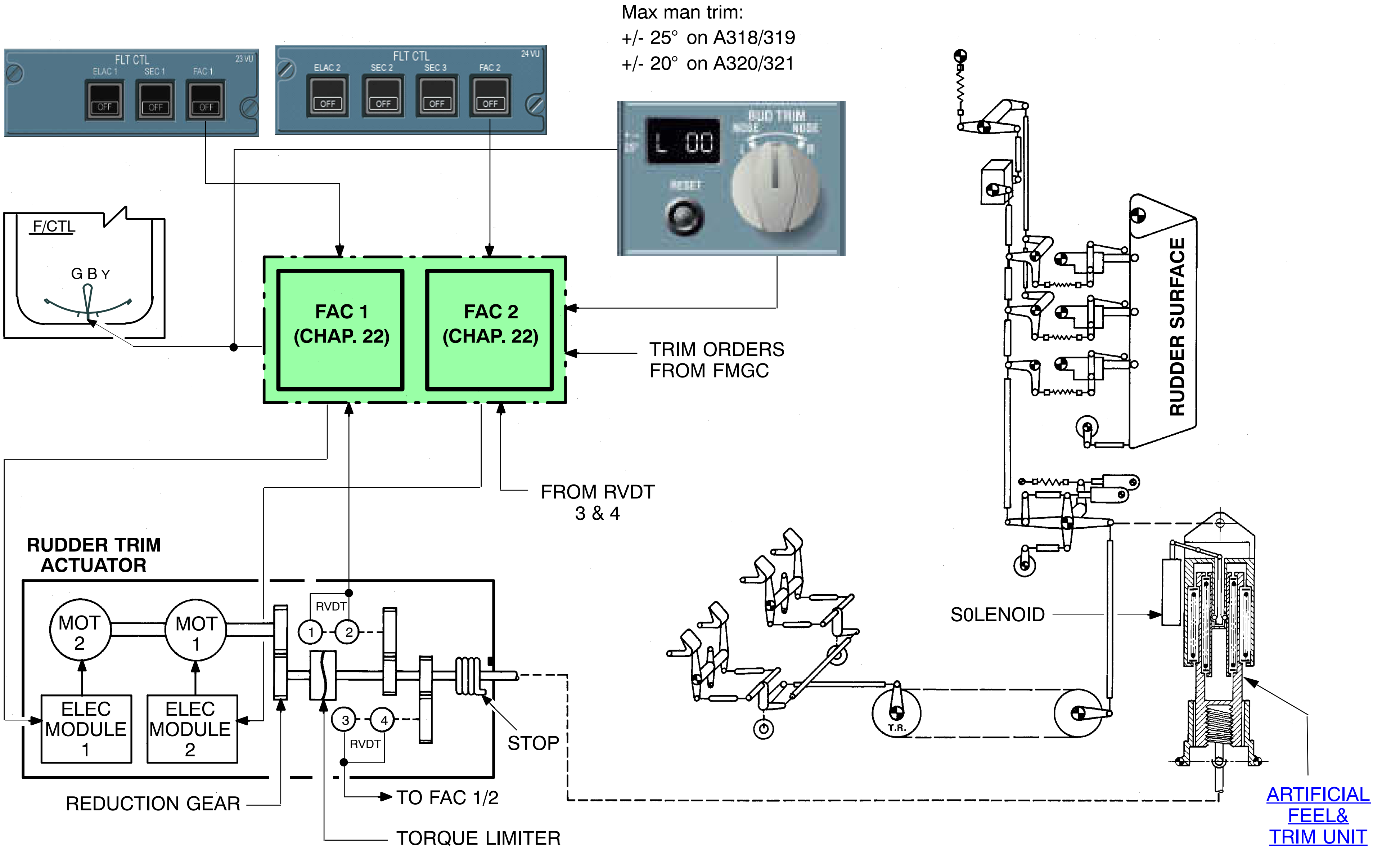


Figure 36 Rudder Trim Control Schematic

RUDDER TRIM/ARTIFICIAL FEEL COMPONENTS DESCRIPTION

Rudder Trim Actuator

The rudder trim actuator consist of two 3-phase motors installed on the same shaft (but they are electrically independent and controlled by independent electronic assemblies).

The motors are permanently coupled to a reduction gear driving the output shaft via a torque limiter.

- non-locking rotary stops limit the actuator stroke

The output shaft after the torque limiter are internally duplicated by a second shaft (this duplication prevents the loss of the four transducers if there is a single rupture). The two output shafts drives four inductive transducer units (RVDT) used as feedback to the FACs.

The primary shaft with two RVDT's is serving the COM in FAC I and the MON in FAC 2 and the secondary shaft serves the COM in FAC 2 and the MON in FAC I.

Artificial Feel & Trim Unit

An artificial feel and trim unit is installed in the vertical stabilizer. The purpose with the system 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.

The artificial feel and trim unit consist of a trim screwjack and a constant resting load spring rod kept in the neutral position by the trim screwjack.

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.

- this system is engaged by a solenoid when the A/P mode is selected.

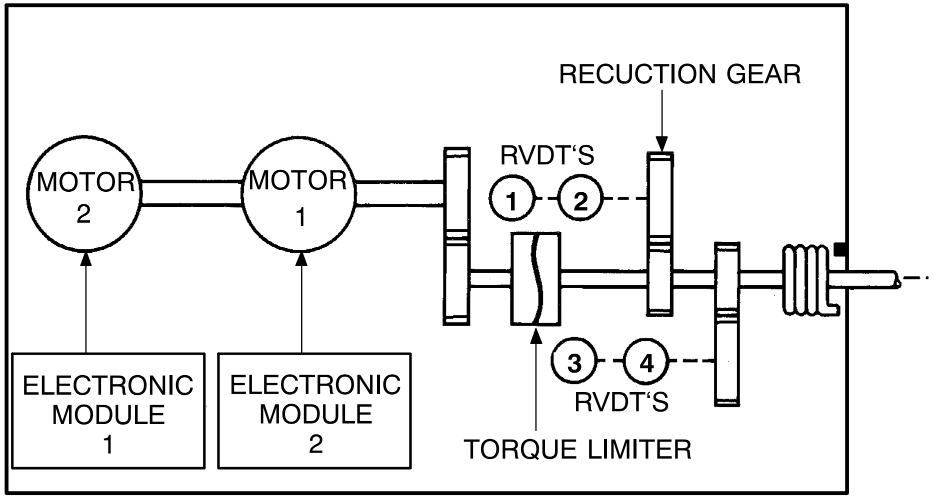


Figure 37 Rudder Trim Schematic

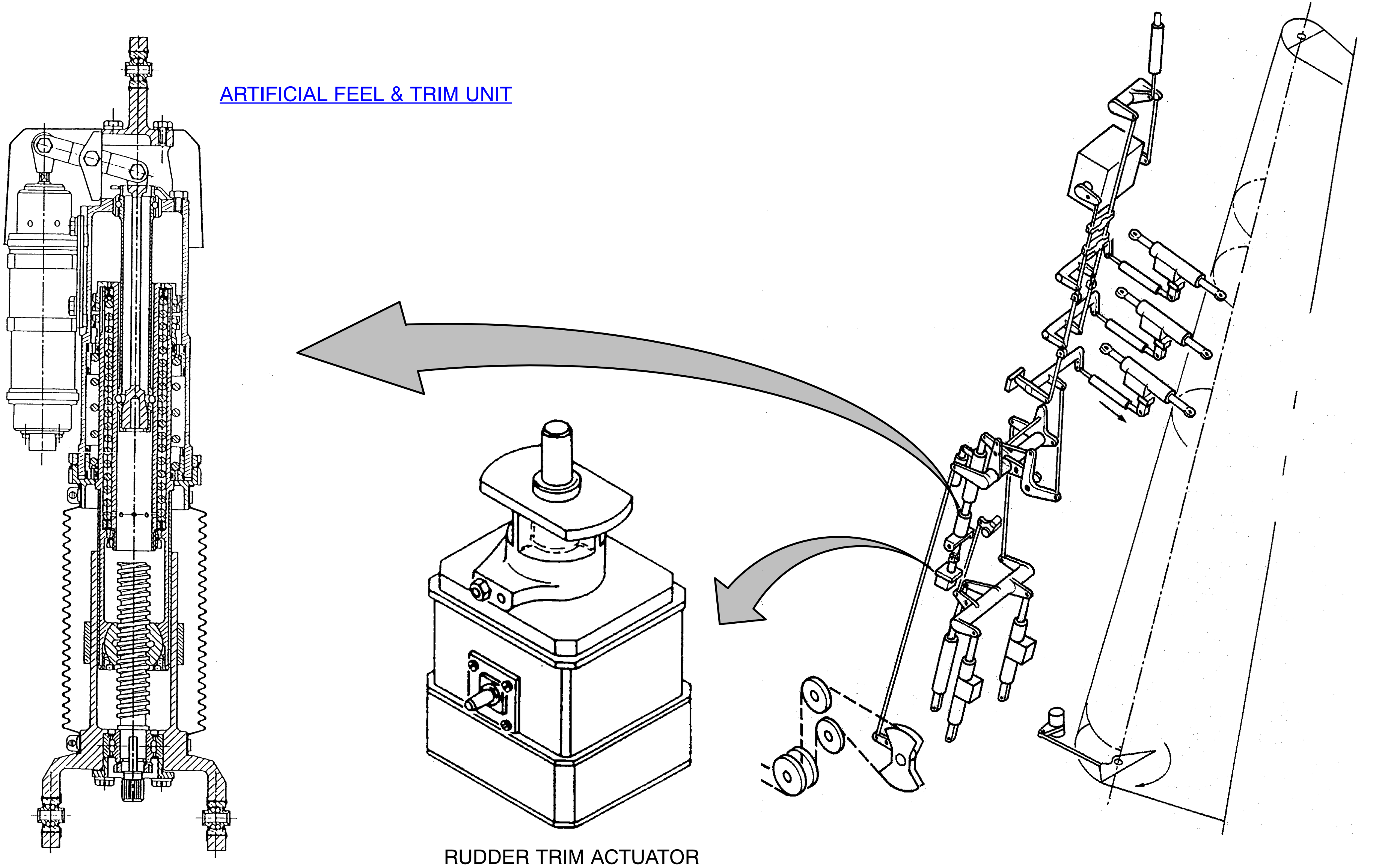


Figure 38 Rudder Trim/Artificial Feel Components

27–26 YAW DAMPER ACTUATION

RUDDER YAW CONTROL SYSTEM DESCRIPTION

General

The yaw orders for turn coordination and yaw damping are computed by the ELACs and transmitted to the FACs.

In flight, yaw damping and turn coordination functions are automatically.

The electrical steering command is send to the two hydraulic operated yaw damper servo actuators. They drive the aft control via a differential linkage.

- the yaw damper servo actuator orders are added to those of the pilots up to the maximum travel that the TLU permits.

One of the two actuators is active (green hydraulic system), the other (yellow hydraulic system) remains in standby (synchronized) and will take over in case of failure.

There is no feedback to the rudder pedals from yaw damping and turn coordination function.

In the event of a double hydraulic failure, a centering spring (yaw damper return spring rod) sets the two yaw damper servo actuators to the neutral position.

Alternate Law

The alternate yaw damper law computed in the Flight Augmentation Computer becomes active if the roll normal law fails. Turn coordination is not longer available.

The alternate yaw damper law also becomes active in case:

- 2 ADRs or 2 IRs or 2 ELACs or both ailerons or all spoilers fail or G+B hydraulic low pressure or loss of pitch normal law.
- The alternate law in FAC 1 is active with the emergency electrical supply (emergency generator running)
- The yaw damper authority is limited to $\pm 5^\circ$ rudder deflection.

Yaw Mechanical

The mechanical rudder control, which is available at all times, must be used when following failures occur:

- 2 FACs or 3 ADRs or 3 IRs or G+Y hydraulic low pressure, or electrical power on batteries only.

NOTE: In case of a dual FAC failure, a specific channel in each FAC selects the rudder limit low speed configuration when the slats are extended.

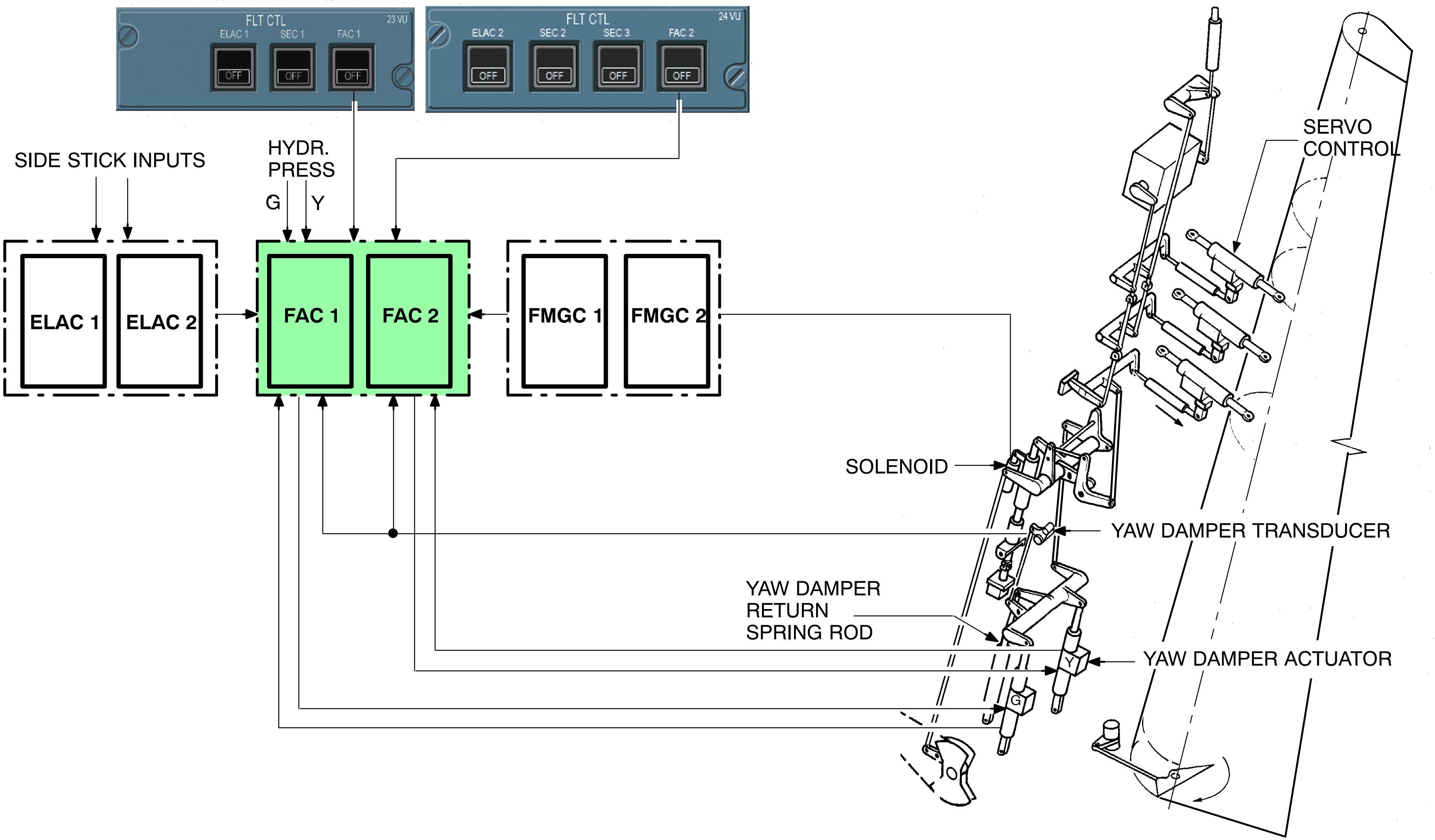


Figure 39 Yaw Control Schematic

YAW DAMPER SERVO ACTUATORS COMPONENT DESCRIPTION

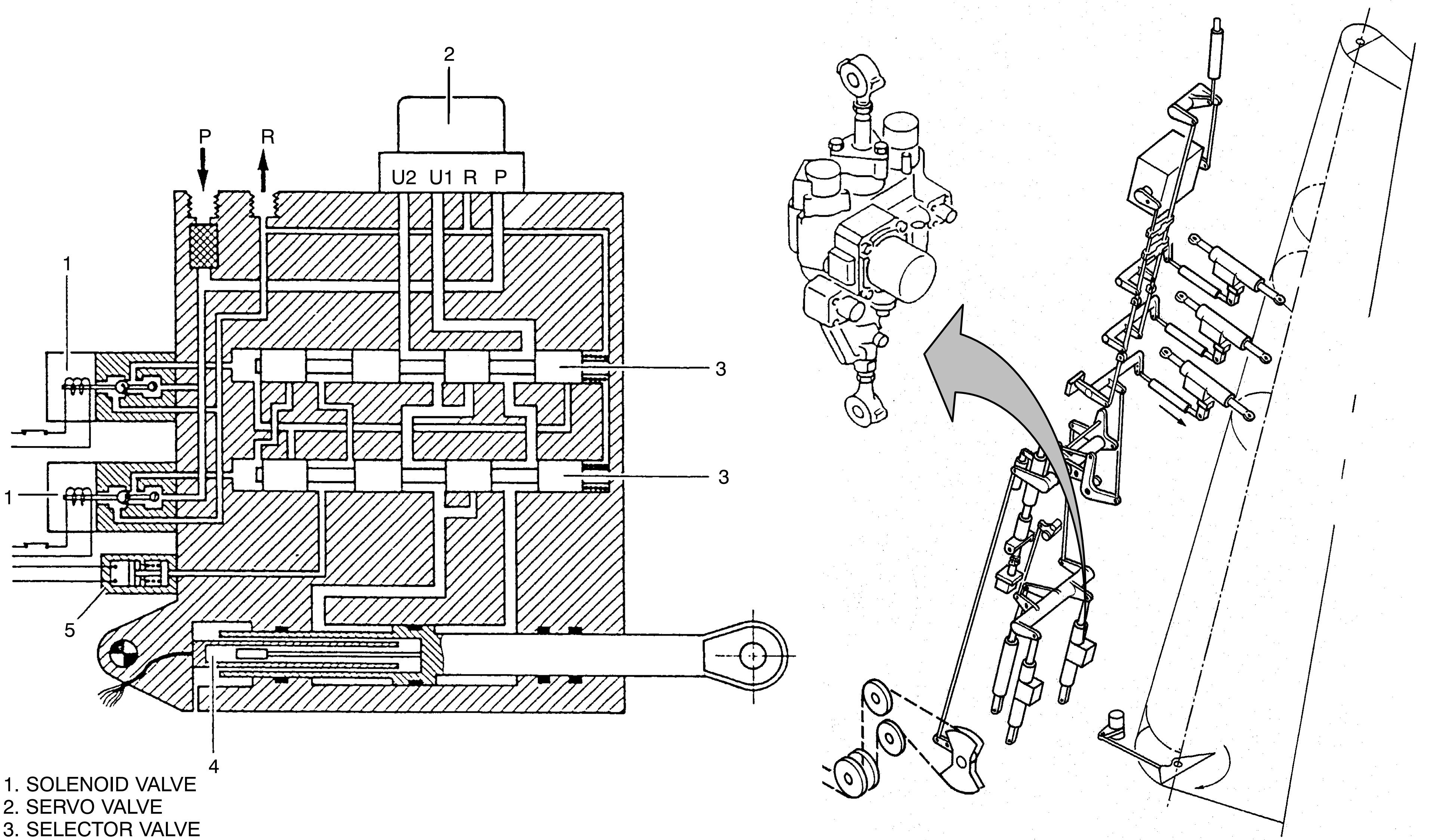
The two Yaw damper servo actuators are equal and interchangeable.

In active mode both solenoids (l) must be energized. The pressure will activate the mode selector valves (3) against the spring force connecting the actuator piston to the servo valve output (2).The pressure switch (5) will be ”open” when both mode selectors are in the active mode. The feed back transducer (4) provides servo loop feedback to the FAC.

The Yaw damper actuator is in by−pass mode when the solenoid valves are de-energized. This will cause the selector valves to move to the rest position, connecting the two piston chambers. The pressure switch remains open.

In case of electrical failure one solenoid valve becomes de-energized causing one of the selector valves to change position and thereby activate the pressure switch signalling the FAC.

Hydraulic failure will cause the actuator to switch to stand−by mode and the pressure switch remains open.



1. SOLENOID VALVE
2. SERVO VALVE
3. SELECTOR VALVE
4. FEEDBACK TRANSDUCER
5. PRESSURE SWITCH

Figure 40 Yaw Damper Servo Actuator

27-23 RUDDER TRAVEL LIMITING

RUDDER LIMITER SYSTEM OPERATION

Low Speed Configuration

Under 160 kts the stops are in low speed configuration. Full input/output lever movement to the rudder servo control is available

Variable Limitation

Between 160 and 380 kts the rudder deflection is limited as a function of a speed . The corresponding law is computed by the FAC's.

High Speed Configuration

Above 380 kts the stops are in high speed configuration. Only limited input/output lever movement to the rudder servo control is available.

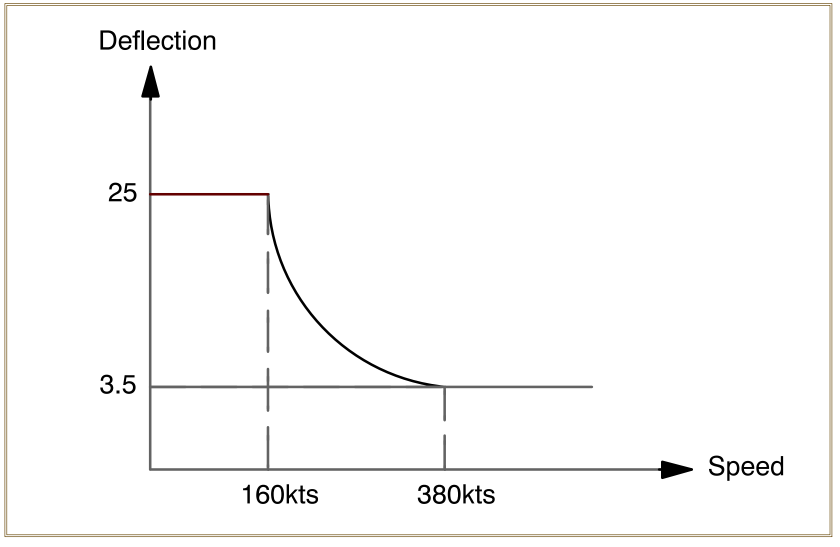


Figure 41 Rudder Limiter Operation

FAC Failure

If both FACs fail, the rudder travel limitation value is frozen immediately.

In this case, the stops return to the low speed configuration when the slats are extended.

Thus, the pilot has full rudder deflection available

Travel Limitation Unit

The TLU has two brush-less electric motors separately controlled by an electronic assy.

Each motor drives a screw, via a reduction gear, and permits the symmetrical linear displacement of two nuts used as adjustable stops. (The two nuts have opposite pitches).

The adjustable stops will limit the output to the rudder servo control actuators and thereby the rudder travel.

A non- locking rotary stop limits the stroke of one of the screw/nut assemblies which are irreversible.

The movement of each screw is transmitted to a transducer unit, via a reduction gear, which permits to indicate the position of the variable stops.

Two rigging pins are used to set the two input/output levers to the zero (mid stroke) position.

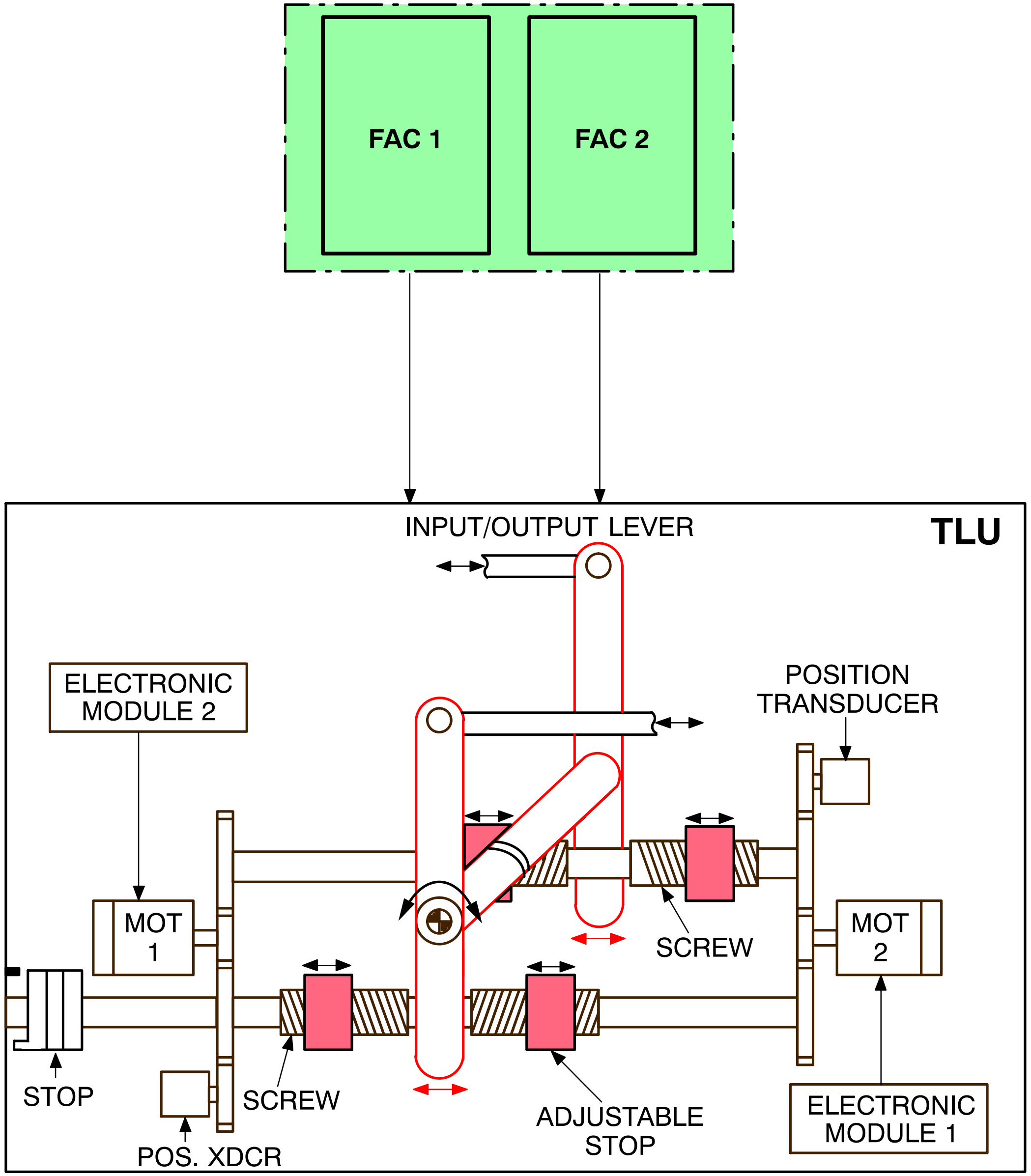
To prevent icing, there is a heating system installed. It includes two heating coils and their regulating thermostat.

Emergency Control Circuit

When the two FACs can not longer achieve normal control, an emergency control brings back the stops to the low speed configuration (maximum possible rudder deflection) when the leading edge slats are extended.

For this the motors are used as 2-phase asynchronous motor energized by 26V 400 Hz power.

This control mode is achieved when the coil of a specific relay (each motor has a relay) is energized for a period of 30 sec approx. This time is sufficient to bring back the stops to the low speed configuration.



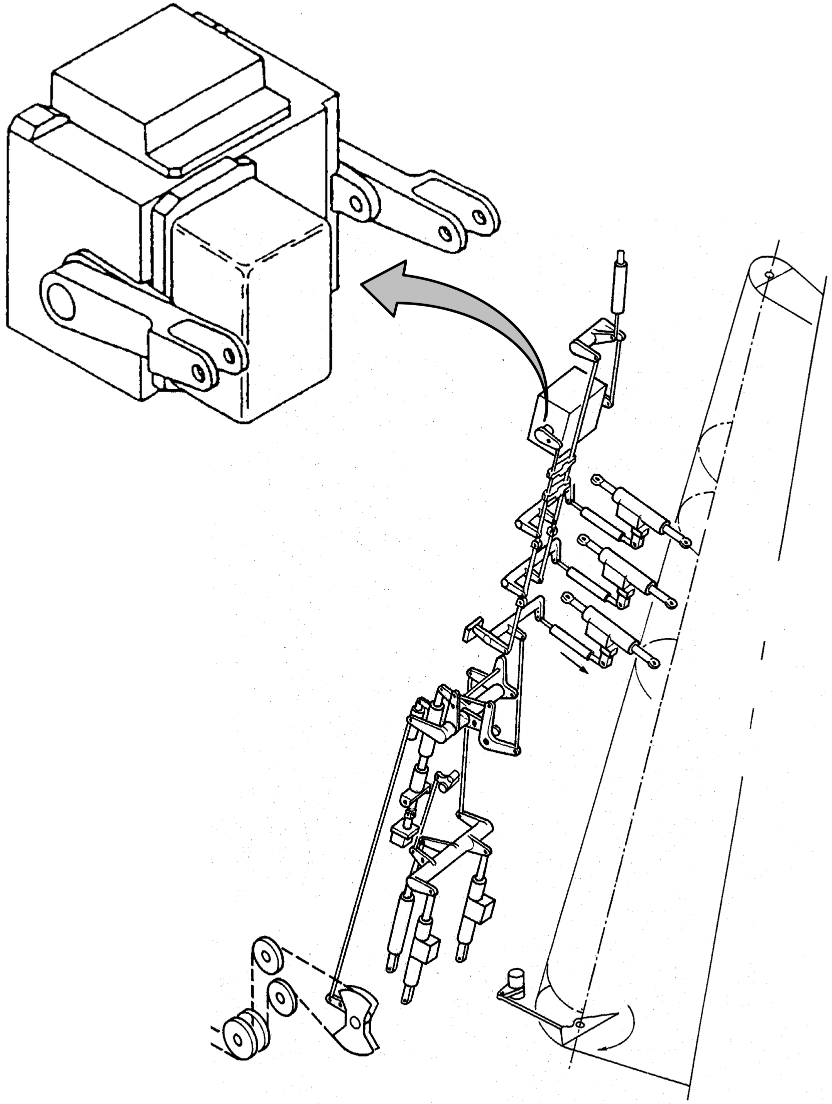


Figure 42 Travel Limitation Unit

27–30 ELEVATOR

PITCH CONTROL SYSTEM DESCRIPTION

General

Control of the aircraft in the Pitch axis is achieved by the two Elevators and the THS (**T**rimable **H**orizontal **S**tabilizer).

The side stick movement (fwd/aft) is signalled to the ELACs and the SECs. ELAC 2 will be in command in normal configuration, operating the two inboard servojacks supplied by the green and the yellow hydraulic system.

ELAC 1 will be in monitor mode and the two outboard servojacks (blue hydraulic system) will be in damping mode.

In case of fault on ELAC 2 or the servojack, the backup will become active and will maintain full control of the surface. If one servojack looses its electrical supply it will be switched to centering mode.

In case of failure on both ELAC I and 2, control of the Elevators are automatically switched to SEC 1 or 2 depending of the status.

NOTE: In case of certain system failures, e.g. SCU monitoring signal lost and therefore actuator being in an unknown mode, the remaining computer may release actuator control to avoid possible force fighting and the elevator will switch to centering mode.

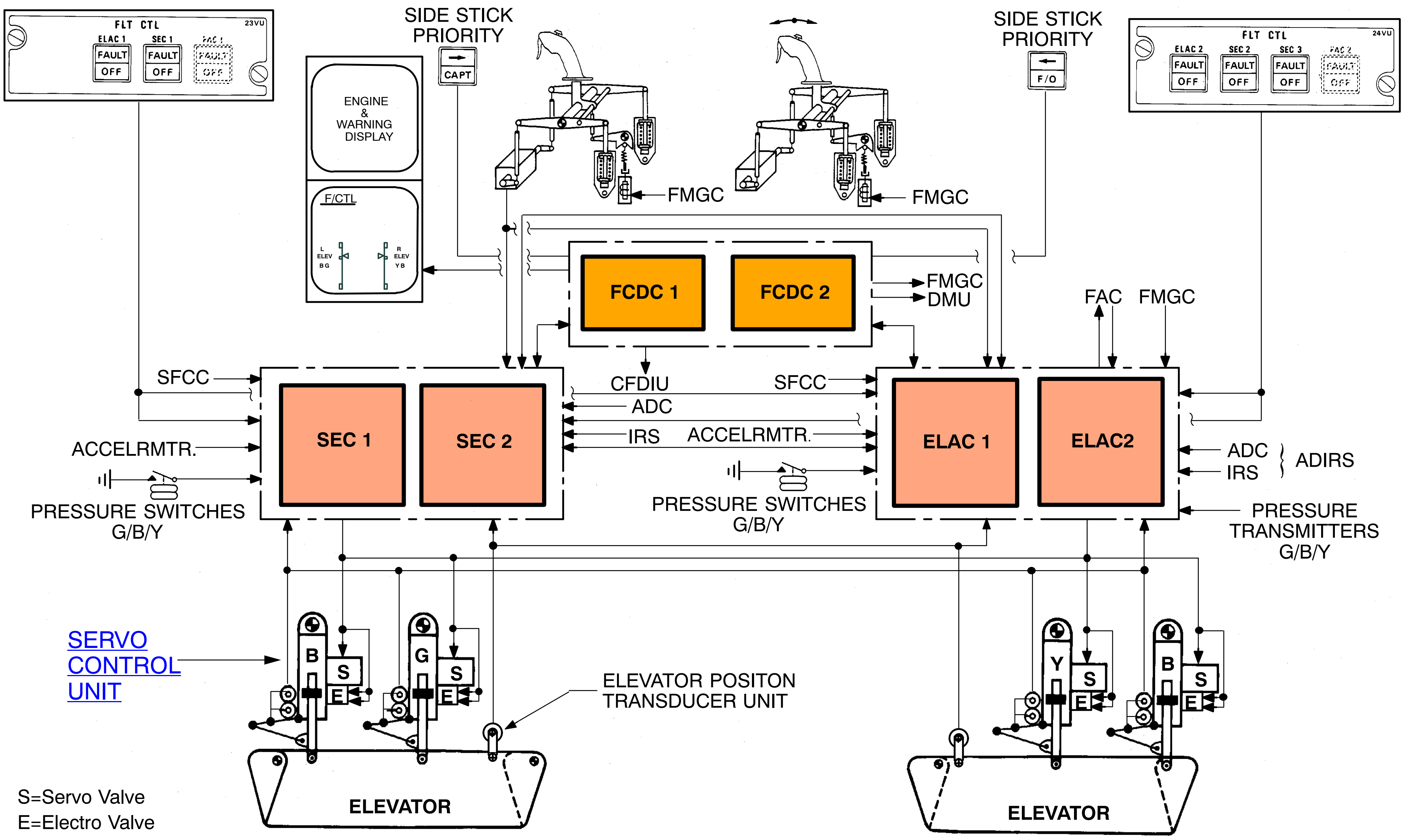
Elevators

Two elevators hinged on the trimmable horizontal stabilizer ensure the pitch control.

Two electrohydraulic servocontrols actuate each elevator. The position of the elevator is shown on the lower display unit of the ECAM system F/CTL page via the FCDC.

The maximum elevator deflection is:

- 30° nose up and 15° nose down
- during take–off when the speed exceeds 70 kts the deflection is limited to 20° nose up and 15° nose down.



S=Servo Valve
E=Electro Valve

Figure 43 Pitch Control Elevator Schematic

PITCH NORMAL LAW FUNCTIONAL OPERATION

The "PITCH NORMAL LAW" is the basic mode for the pitch control. The law elaborates a "load factor demand" from the position of the side stick and the inertial feed backs. The law is identified as "flight envelope protections", including:

- manoeuvre protection
- angle of attack protection
- high speed protection
- pitch attitude protection.

The pitch computers senses the flight phase and can operate in:

- Ground mode
- Flight mode
- Flare mode

R/A altitude, left and right shock absorber ground signal from the LGCIUs and Longitudinal attitude from the ADIRS are used to detect the flight phase.

In GROUND MODE the side stick output directly controls the Elevator position, also called "PITCH DIRECT LAW".

The auto stab trim is suppressed. Manual stab trim is available (4° A/C nose down to13,5° A/C nose up). During take of, at 70 kts, the elevator deflection is limited from 30° nose up to 20° nose up.

FLIGHT MODE becomes active after lift off. The automatic THS becomes active and is progressively blended in over a period of 5 sec.

- automatic pitch trim takes care of trim changes because of speed, thrust and configuration. After each elevator deflection, it trims the aircraft at neutral elevator.

The "LOAD FACTOR DEMAND" is active, sensing the side stick deflection, speed and CG (**C**enter of **G**ravity) as calculating factors. With the stick in neutral position the system will maintain a load of 1g in pitch, corrected for pitch attitude. Flight envelope protections are also active.

FLARE MODE becomes active during decent at 50 ft R/A altitude. The pitch attitude is memorized and maintained. At 30 feet the attitude is reduced to 2° nose down over a period of 8 sec. Pilot action is thus required to flare the aircraft prior to touch down.

At landing, the auto stab trim is faded out and the stab will revert to 0° position.

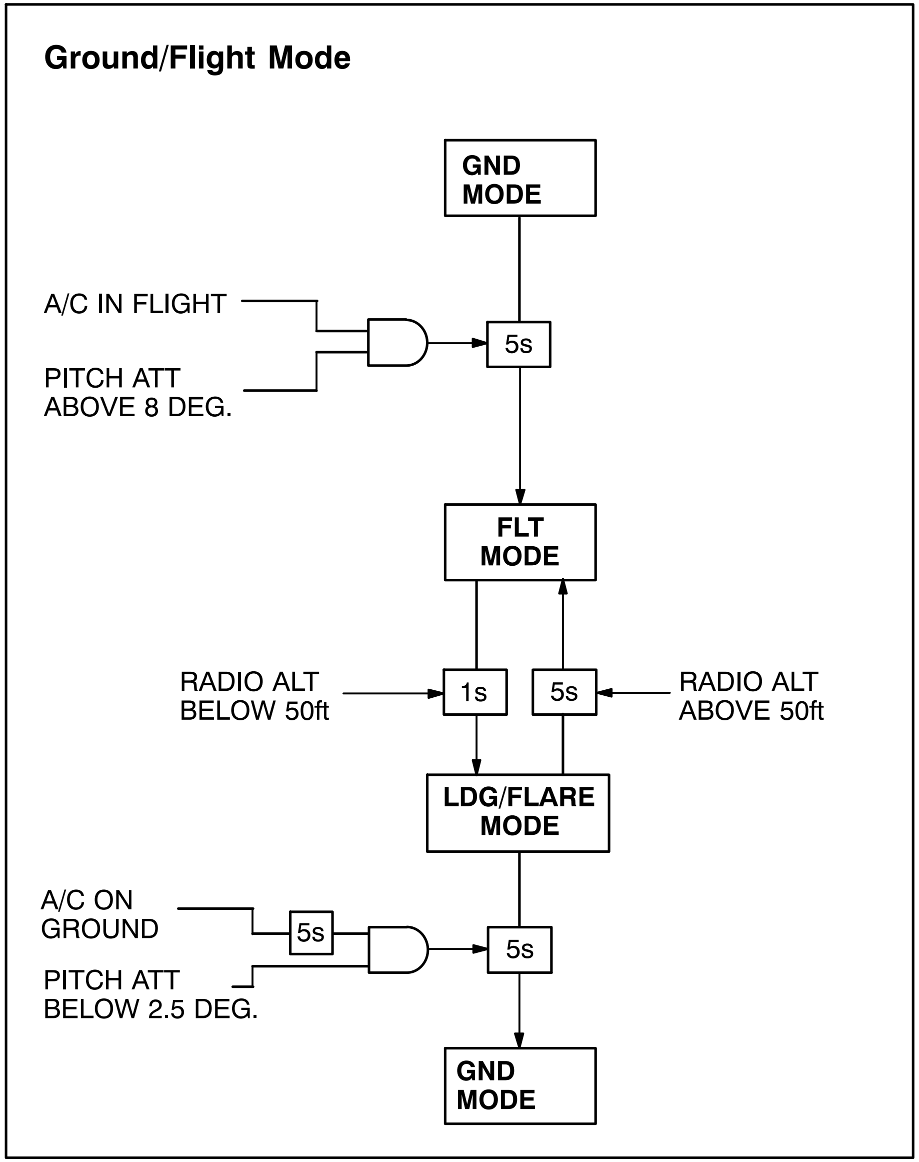


Figure 44 Pitch Normal Law

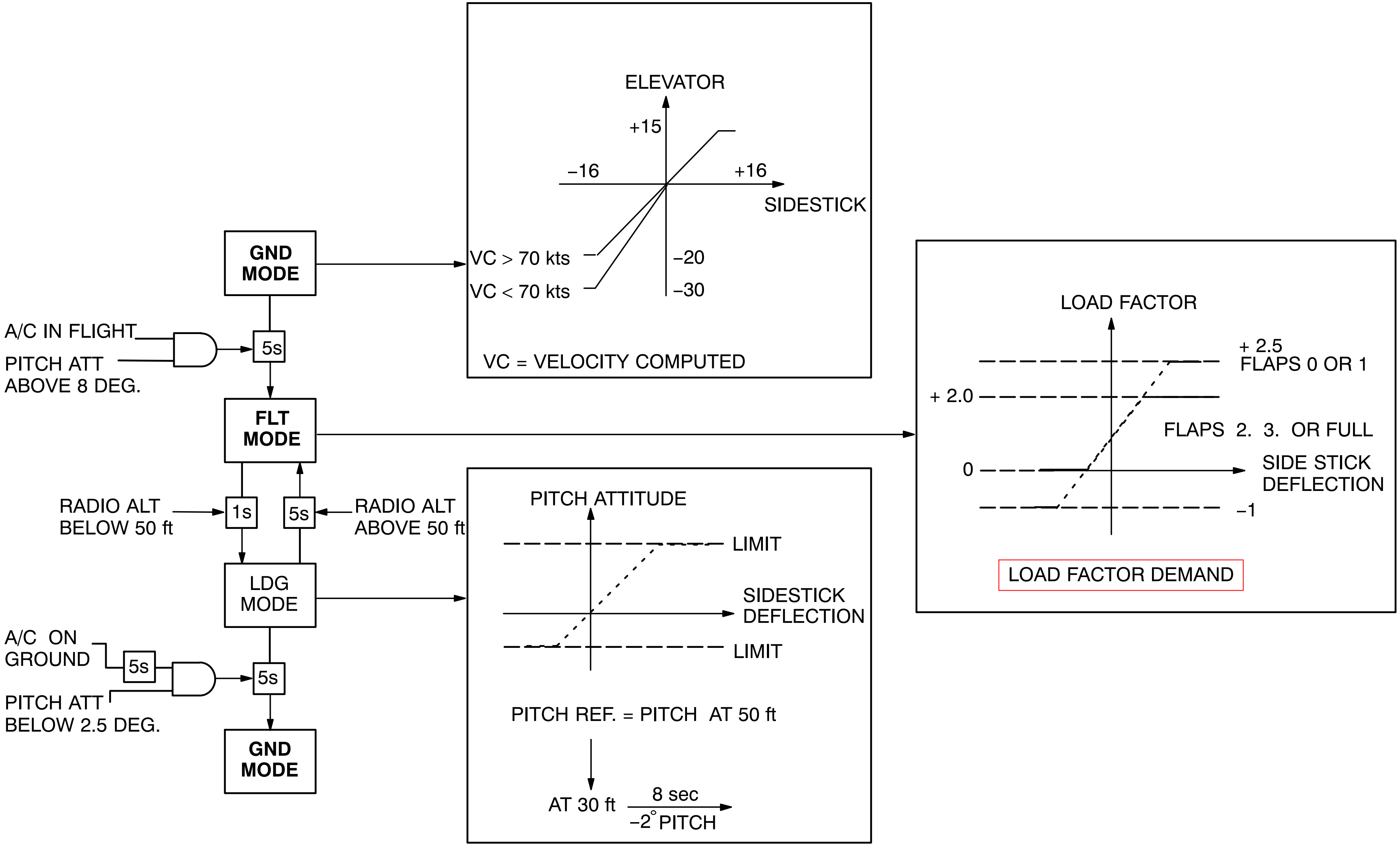


Figure 45 Pitch Law Diagram

FLIGHT ENVELOPE PROTECTIONS

AOA (Angle of Attack) Protection

The ∝ Prot system will prevent the pitch angle to develop into the stall area. The system also assist the pilots in a windshear situation. The ∝ Prot has the highest priority and is active from lift off to 100 ft radio altitude before landing.

The ∝ Prot speed versus the A−O−A and aircraft configuration is calculated by the two FAC's and are displayed on the speed scale on the left and right PFD. The scale indicates the min safe speed (VLS), the ∝ Prot speed and the ∝ Max speed.

In pitch normal law, when the angle of attack becomes higher than the a prot threshold, the elevator control is switched to a protection mode where A−O−A is proportional to the side stick deflection. The ∝ Prot value is associated to a null order of the sidestick and the ∝ Max is associated to a full nose up command.

When ∝ Floor is reached the Auto Thrust System will trigger and provide full take off power at both engines, regardless of the power lever position.
The ∝ Max angle can not be exceeded, even if the side stick is pulled fully back, the ∝ Max angle will be maintained . When the stick is released the A−O−A returns to and maintain the ∝ Prot angle.
To deactivate the ∝ protection the side stick must be pushed forward more than 8°.

When the auto thrust system is triggered in the ∝ Prot situation, the center of the EPR indicators will display "A FLOOR" in amber.

High Speed Protection

High Speed Protection activates an automatic pitch up signal when the VMO or VMM limit is exceeded. The VMO/VMM (VMO = Max Operating Speed; VMM = Max Manoeuvre Speed) is calculated by the FACs and is displayed on the PFD speed scale as a red interrupted bar.

The overspeed protection symbol is also displayed on the speed scale and consist of two green bars on the calculated VMO + 6 kts.

A positive load factor is demanded as soon as the speed becomes greater than VMO + 6 or MMO + 0.01. A pitch up load factor demand with a max authority of 0.75g is added to any pilot input. The pilot authority in the nose down sense is reduced and can not overpower the automatic pitch up.

The High Speed Protection system will limit the speed to VMO + 16 and Mach to MMO + 0.04 even if the pilot apply full forward stick. If full forward stick is applied the speed will be maintained between VMO and VMO +16.

With released side stick, the pitch channel will maintain VMO or the mach number at MMO. The system is deactivated when the speed returns to the VMM/VMO limit.

Pitch Attitude Protection

The pitch attitude is limited to 30° nose up to 15° nose down. The nose up limit is reduced to 25° at low speed. The limits are displayed by green = symbols on the PFD.

The attitude limitation is calculated by the FAC's and can not be overridden. When alternate or direct law is active the protection is lost and the limit symbols will change to amber "X".

Manoeuvre Protection

Manoeuvre protection will limit the load factor to + 2.5g to − 1g when the flaps are retracted during high speed. The limit is changed to + 2g to 0g when the flaps are extended.

The High Speed Protection and the Load Factor Protection when active will inhibit automatic stabilizer trim.

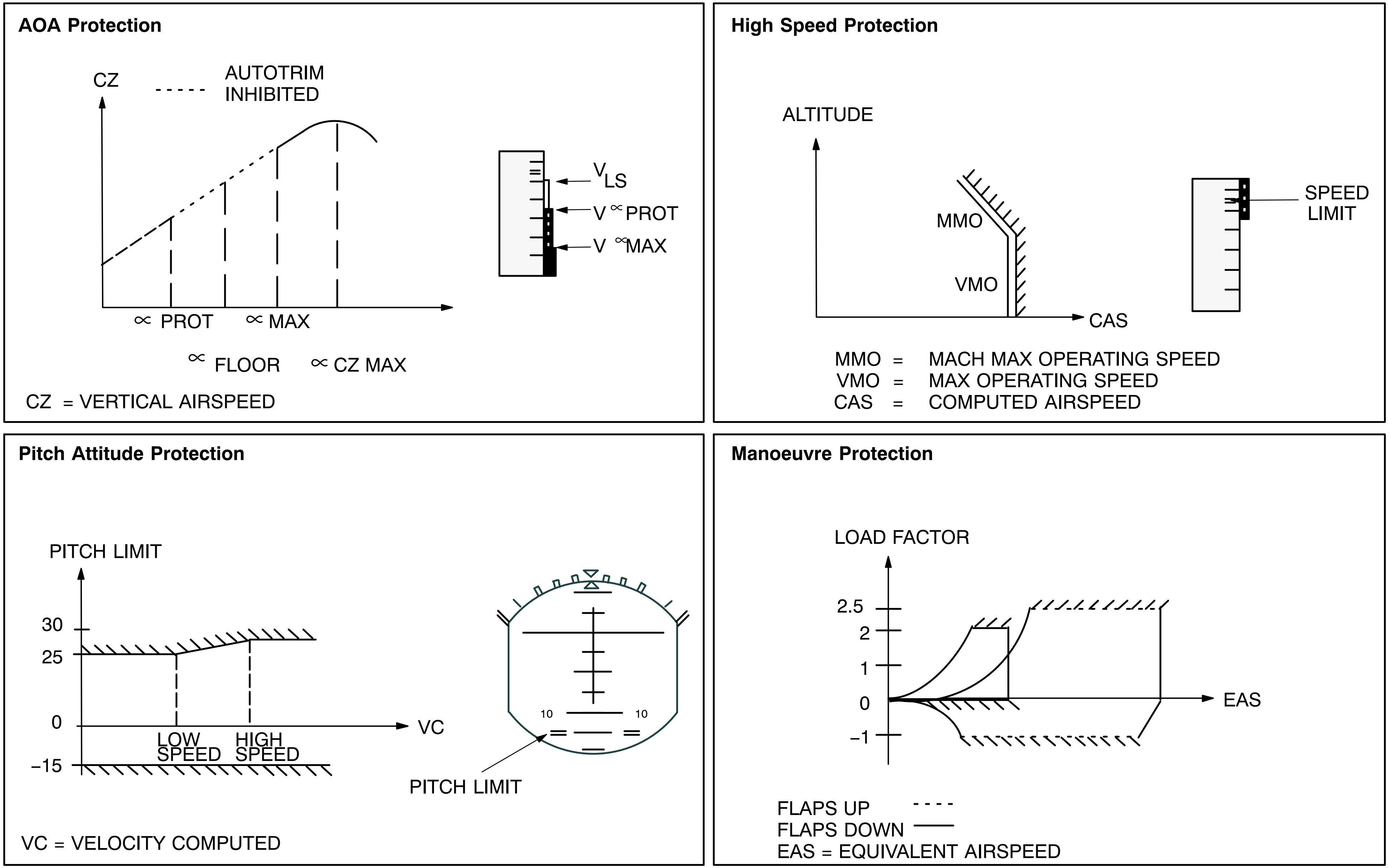


Figure 46 Flight Envelope Protections

PITCH ALTERNATE LAW

The Pitch Alternate law becomes active when the information necessary for the Normal Law can no longer be consolidated.

Alternate Law can also be activated at certain system failures.

In general normal law will be maintained when the following are operative:

- 1FAC
- 1 SEC
- 1 ELAC
- 1 SFCC
- 1 R/A
- 2 IRSs
- 2 ADCs

Thus a dual computer, sensor or hydraulic system failure will downgrade the flight control channel to Alternate Law.

In Flight Alternate Law the gains are dependant of the aircraft configuration. The Pitch Rate is limited to 5°/sec

The Pitch Flare Law is replaced by the Direct Law when the landing gear is extended

In Flight Alternate Law, the Load Factor Demand will remain active and the Flight Envelope protection system is modified.

The Pitch Attitude protection is deactivated, indicated by amber "X" at the +30° and the −15° position on the PFD's.

The ∝ Prot is replaced by a Low Speed Stability protection.

When the speed comes below a threshold of approximately 143 kts with slats extended or 173 kts in clean config a negative load factor is introduced to prevent the speed from further decrease. The PFD low speed scale is also modified.

A aural "STALL" synthetic voice warning with cricket sound is introduced at a certain margin from the stall condition.

The High Speed Protection is modified.

Above VMO a nose up demand is introduced, the signal can be overridden. The overspeed symbol at VMO + 6 is replaced by a amber " X " and a conventional aural overspeed warning is introduced at VMO + 4 kts, MMO + 0.01.

The manoeuvre protection is similar to Normal Law.

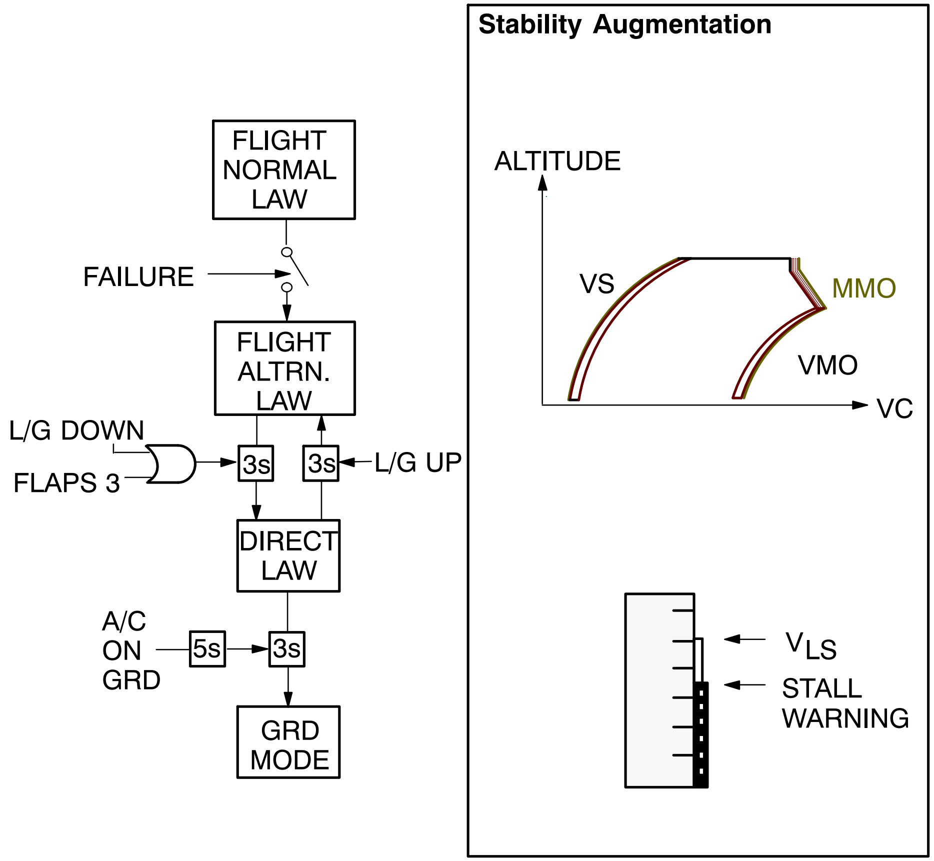


Figure 47 Pitch Alternate Law

This diagram summarises the pitch law reconfiguration

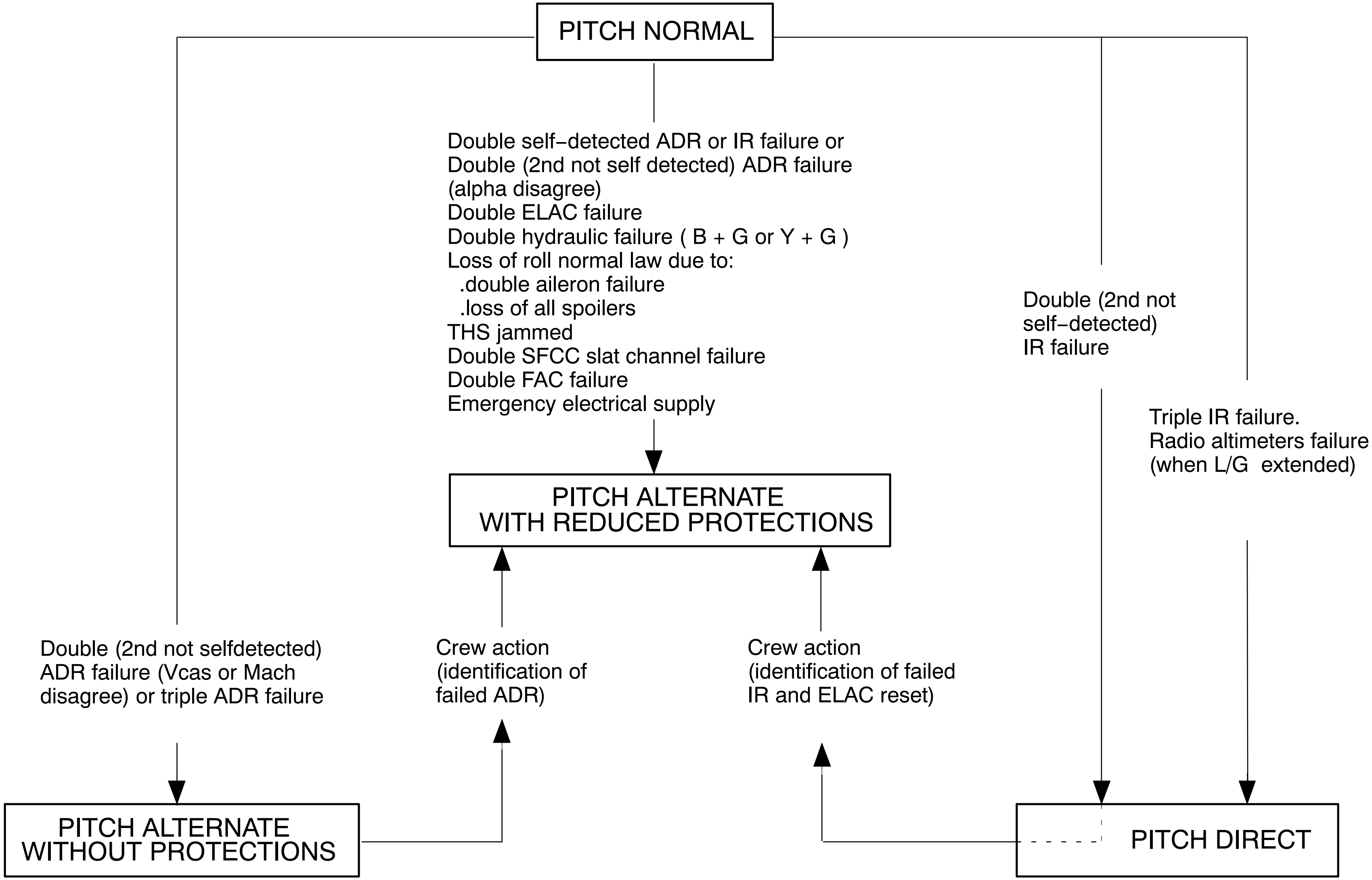


Figure 48 Pitch Law Reconfiguration

PITCH DIRECT LAW

The Pitch Direct Law can come into effect if the Normal or the Alternate Law can no longer be maintained.

In Direct Law the elevator deflection is directly controlled by the side stick and the automatic stab trim is frozen. No flight envelope protections are active. The stall and overspeed warnings are operating as in Alternate Law.

The Pitch Direct Law will also become active when the aircraft is operated in Alternate Law and the landing gear is extended, or flaps 3 is selected.

When in Direct Law "USE MAN TRIM" in amber is displayed in the PFDs.

Pitch Back Up is achieved through the manual operated THS. In this case the side stick is inoperative and the PFDs will display "MAN PITCH TRIM ONLY" in red.

Abnormal Attitude Laws

An abnormal attitude law in pitch and roll is provided if the aircraft is in flight and any of these conditions is exceeded:

- Pitch attitude > 50° nose up or 30° nose down
- Bank angle above 125°
- Angle of attack > 30° or < -10° (-15° for A321)
- Speed > 450 kts or < 60 kts
- Mach > 0.91 or < 0.1

The law in pitch is the Alternate Law without protections (except load factor protection) and without auto trim.

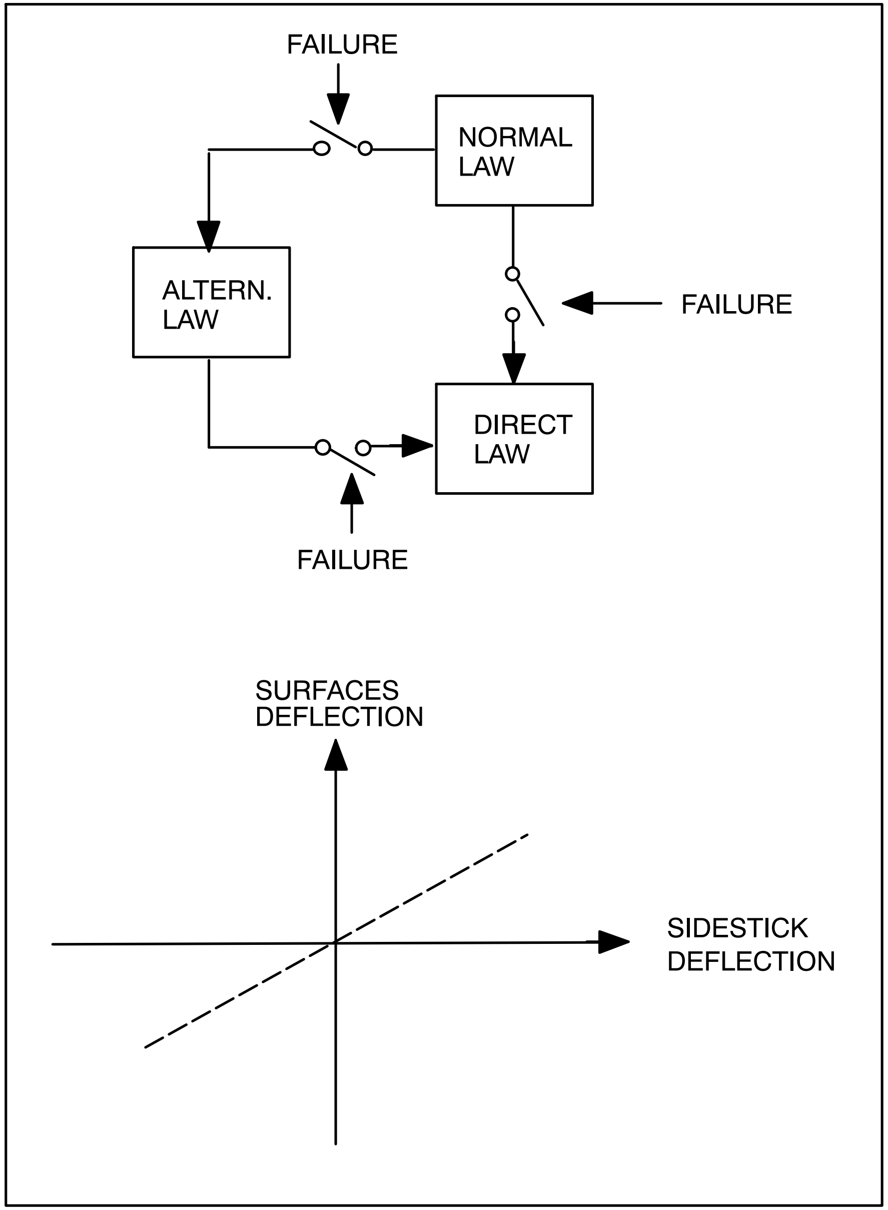
In roll it is a full authority direct law with yaw mechanical.

Autopilot Pitch Control

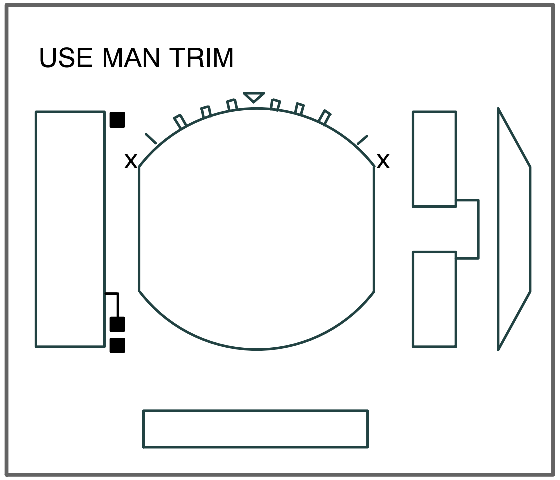
Autopilot Pitch Control requires at least one operative ELAC. The A/P by means of the FMGC signals the ELAC. When the A/P is engaged the side stick will be frozen in the detent position. If the pilots override the detent threshold the A/P will disconnect.

The A/P will also disconnect if:

- high speed protection active
- $\propto$ protection active
- bank angle more than 45°



PITCH DIRECT LAW



PITCH BACK-UP (SIDESTICK INOP)

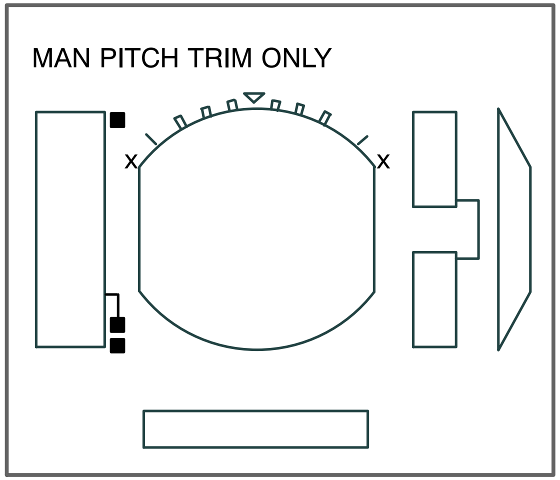


Figure 49 Pitch Direct Law

27–34 ELEVATOR & HYD ACTUATION

ELEVATOR SERVO CONTROL COMPONENT DESCRIPTION

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 solenoid valves (1) de–energized and pressure line closure valve (2) open, return line closing valve (3) also open, connecting the actuator to pressure and return. The high pressure flow will thus activate the mode selector valve (5).The mode selector LVDT (11) will provide mode feed back to the ELAC and SECs.

Steering input from the side stick or the FMGC is routed via the EFCS computer in command to the servo valve (4), controlling the actuator piston. Servo loop feed back to the EFCS is provided by the position RVDT (10). The second RVDT is back–up, used in case of failure. The servo valve transducer (12) is used for monitoring.

Damping mode means solenoid valves (1) are energized, powered from the standing–by ELAC and SEC. The mode selector valve is displace due to the spring, this causes the interconnection of the two actuator chambers through the damping orifice (6). The mode selector LVDT identifies the mode change to the EFCS.

A certain amount of reserve fluid is maintained in the actuator by the reserve reservoir (9) and the check valve (7) to hold the volume of fluid if there is a leakage or if the hydraulic fluid temperature changes.

When the Elevator surface is moved by the active actuator, the actuator in damping mode will follow the movement and provide a certain resistance to the movement.

Centering mode becomes active in case of loss of power to all **4** controlling computers and hydraulic pressure are still present.

In case of certain system failures, e.g. SCU in unknown mode, the centering mode may also become active even if one related computer is still functional to avoid possible force fighting.

The centering device (13) mechanically keeps the actuator in the center position, preventing movement of the surface.

The deflection of the remaining surface is in this case limited in order to prevent excessive asymmetrical load on the tailplane and the rear fuselage.

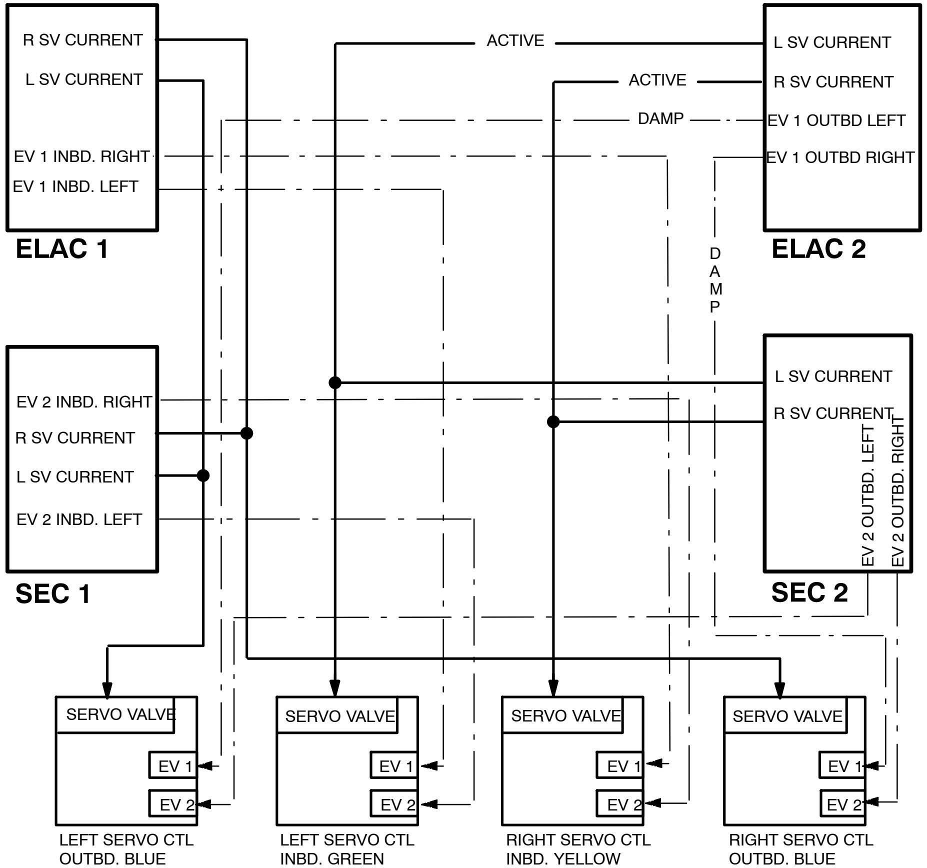
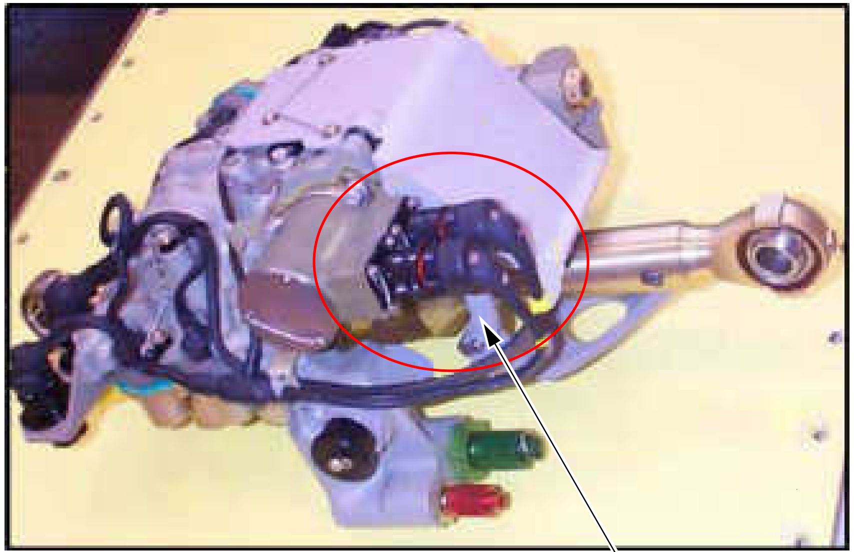
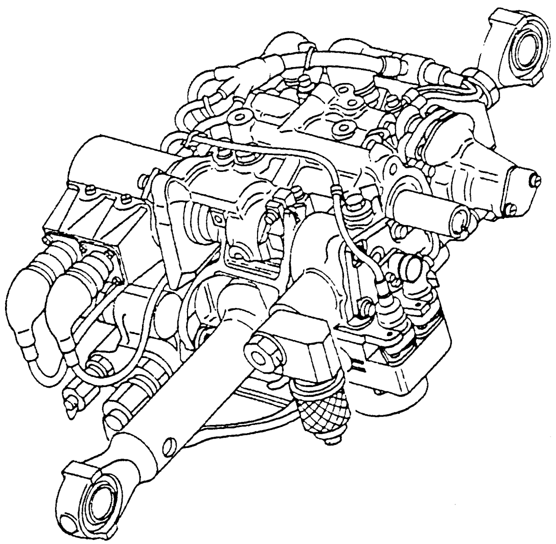


Figure 50 Elevator Servocontrol Schematic



1. SOLENOID VALVE
2. PRESSURE LINE CLOSING VALVE
3. RETURN LINE CLOSING VALVE
4. SERVOVALVE
5. MODE SELECTOR VALVE
6. DAMPING ORIFICE
7. CHECK VALVE
8. RETURN RELIEF VALVE
9. FLUID RESERVE
10. FEEDBACK TRANSDUCER
11. MODE SELECTOR VALVE TRANSDUCER
12. SERVO VALVE TRANSDUCER
13. CENTERING DEVICE
14. SERVOVALVE MECHANICAL INPUT
15. DRAIN FOR FLUID RESERVE
16. DIFFERENTIAL PRESSURE INDICATOR

XDCR ELEC CONNECTORS (10.)
(MAY BE SWAPPED ACCORDING AMM)



SERVO CONTROL UNIT

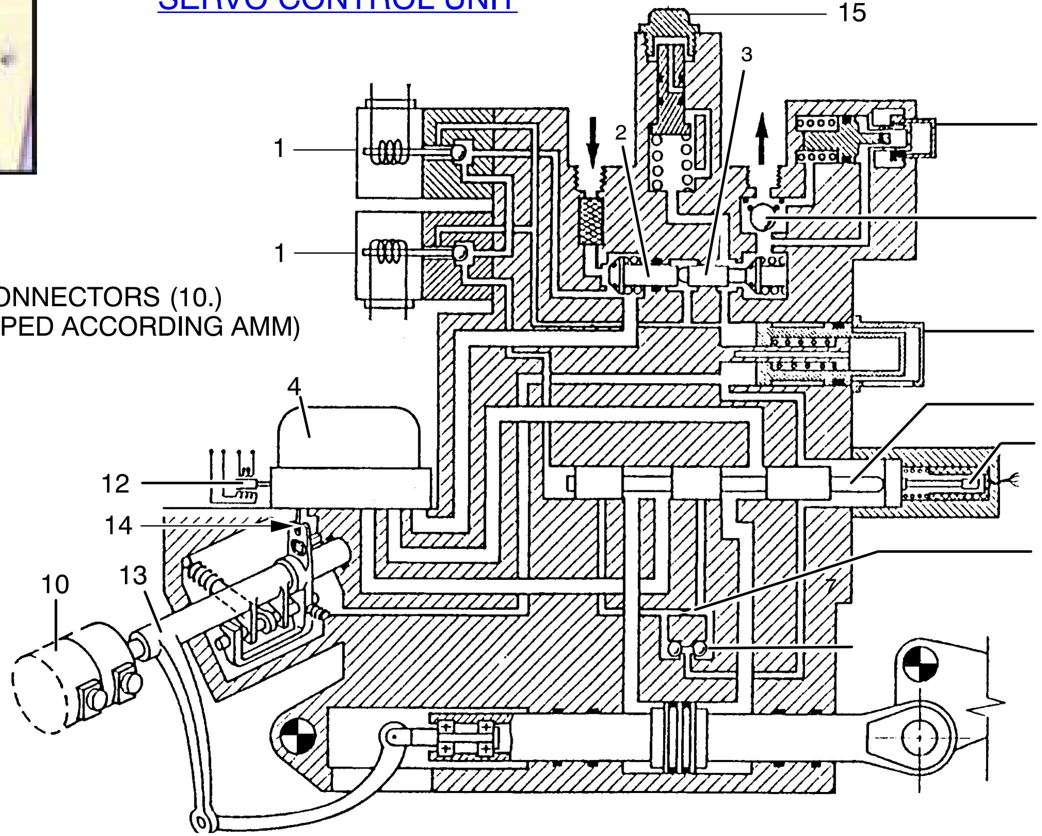


Figure 51 Elevator Servo Control

27–40 TRIMABLE HORIZONTAL STABILIZER (THS)

PITCH TRIM SYSTEM DESCRIPTION

General Description

Pitch trim is achieved by the Trimable Horizontal Stabilizer. The two elevators are hinged on the THS.

The THS is actuated by a screw jack driven by two hydraulic motors. The dual hydraulic motors are activated by one of three electrical motors or the manual trim wheel.

- the max movement of the THS is 13,5° A/C nose up and 4° nose down (the stops of the actuator ballscrew are 13,8° and 4,3°), corresponding to 6,32 and 1.87 revolutions on the pitch trim wheel. The rate of travel is 1°/sec.

In normal configuration ELAC 2 signals electrical motor number 1 driving the two hydraulic motors with hydraulic pressure from green and yellow system.

In case of failure ELAC 1 will go in command operating motor 2. Dual ELAC failure will transfer the operation to the SECs and the motors 2 or 3.

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.

Mechanical input from the trim wheel holds priority over the input from the ELACs.

The pilots can override the electrical control via the mechanical control system, through the application of a sufficient force to the control wheels.

An override mechanism in the THS actuator is used for this purpose. The override mechanism reverts to the electrical control after release of the mechanical control.

The THS actuator has two position transducer units installed. The command transducer unit detect the position of the override mechanism output/input control. The monitor position transducer is used to find the position of the ball screw. They both provide feedback signals to the ELACs and SECs.

- the signal from the monitor transducer unit is used as well as for the position indication of the THS on the ECAM F/CTL page.
- on the center pedestal, adjacent to each pitch trim control wheel, the THS position is indicated by an index on a scale.

There is a reference mark painted on the THS and on the adjacent structure.

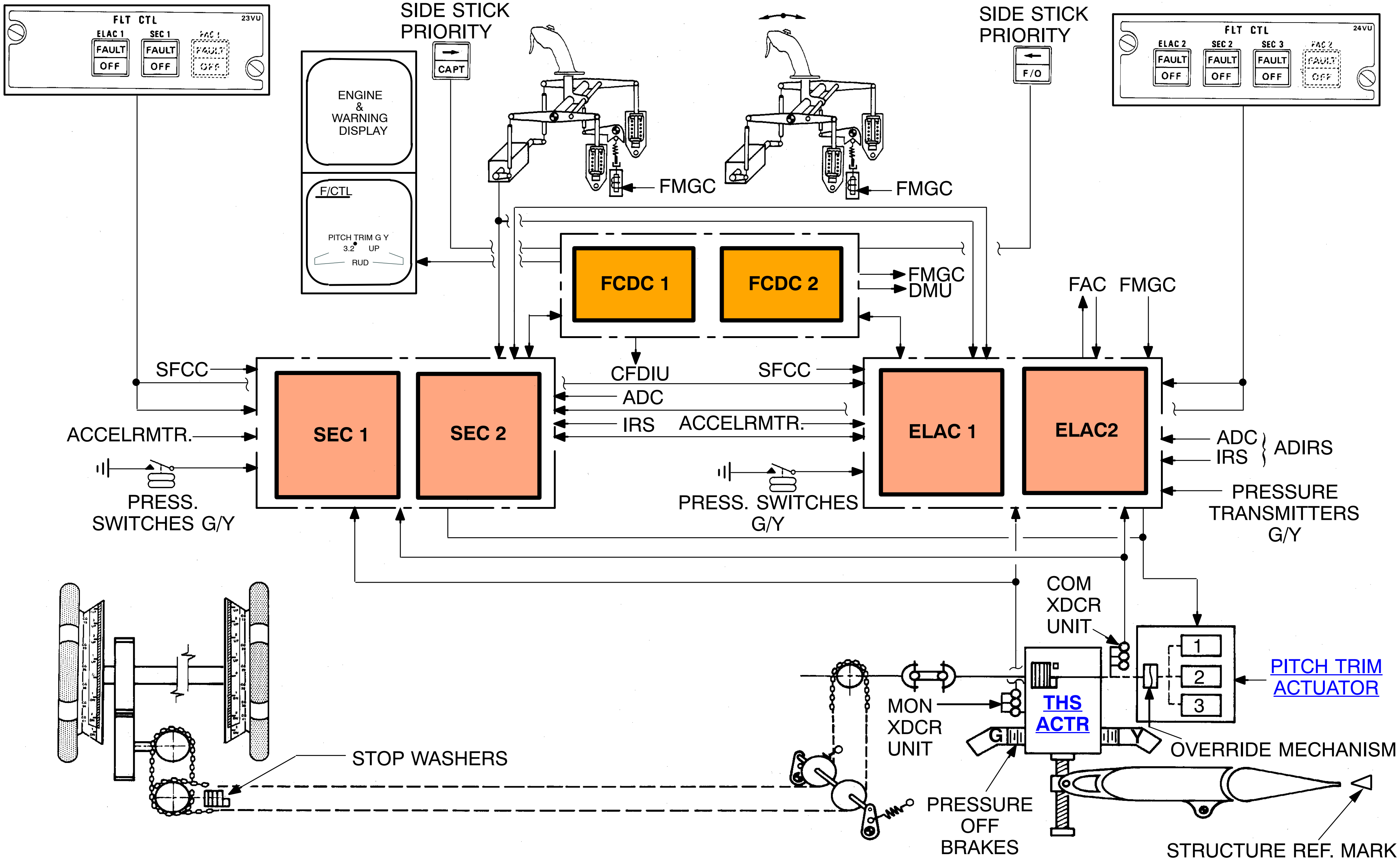


Figure 52 Pitch Trim Schematic

27−41 THS MECHANICAL CONTROL

THS MECHANICAL CONTROL SYSTEM DESCRIPTION

Description

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.

The actual stabilizer position is indicated on a scale on the side of the wheel, with the take off range in green.

The trim wheels are via a chain connected to a sector underneath the cockpit floor. From the sector a single set of cables are running back to the stabilizer compartment to the cable tension regulator.

The regulator will maintain the cable tension with variations in the temperature.

The cable input is connected to the input shaft on the override mechanism of the actuator. If the PTA (**P**itch **T**rim **A**ctuator) is in off mode, the override mechanism remains off and the input is transmitted directly to the hydraulic motor control valves.

If the PTA controls the THS, the manual command signal causes the override mechanism to brake out and the manual input will go directly to the control valves and thus override the PTA signal.

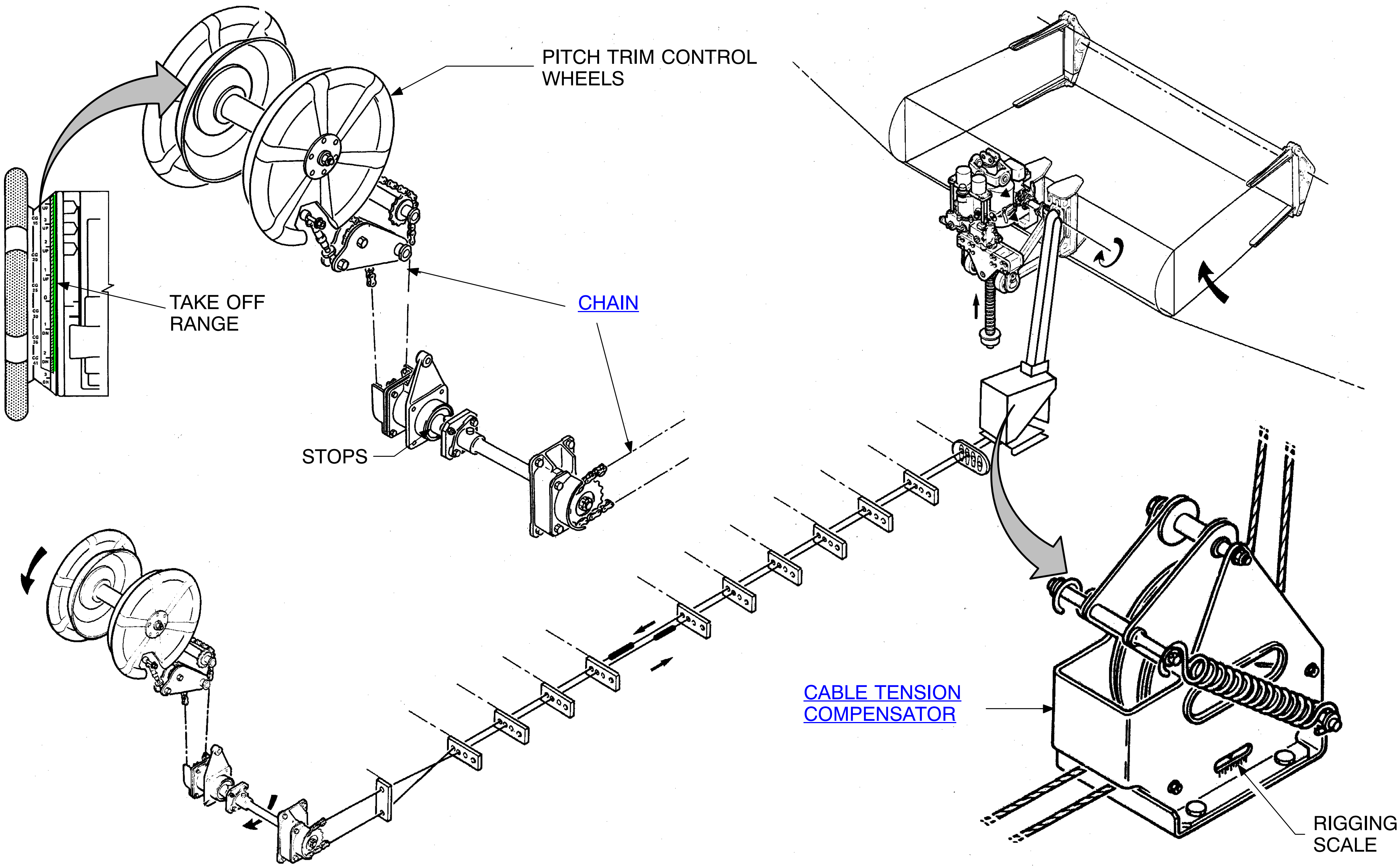


Figure 53 THS Mechanical Control

27−44 THS HYDRAULIC ACTUATION

THS ACTUATOR SYSTEM DESCRIPTION

Description

The THS is driven by a hydraulic actuator rotating a ball screwjack. The screwjack is connected to a ball nut attached to the leading edge of the Stabilizer box, moving the stabilizer over the pivot point located left and right hand side at the trailing edge of the stabilizer box.

The stabilizer actuator is operated by two hydraulic motors supplied from the green and the yellow hydraulic systems. The motors are operating the actuator via a planet gear, making it possible to operate the THS with only one motor.

Input to the two hydraulic motors comes from a PTA (**P**itch **T**rim **A**ctuator) via a gear train. The PTA is equipped with three electrical servo motors signalled by the ELAC's or the SEC's number 1 or 2. One servo motor will be active at any time.

The rate of travel of 1°/sec is obtained in normal mode where the THS actuator is operated by both hydraulic motors. In case of loss of hydraulic power from one system the THS will operate on half speed. In case of total loss of hydraulic power or control signal, the actuators makes sure the THS is fully immobilized.

The screwjack is equipped with a No−Back brake of ratchet and pawl type, keeping the ball−screw in the last position, preventing the stabilizer to move by aerodynamic loads.

A no−back wear detector is installed on the lower side of the gearbox. A red indicator arm will be visible in case of excessive wear.

The fixed displacement type hydraulic motors contains Pressure−off brakes with the purpose to prevent movement of the motors when the hydraulic pressure is off. It thus lets the other motor control the ball screw through the power differential gear.

In case of failure of the pressure−off brake a indicator under the valve block will be displayed.

THS ACTUATOR COMPONENTS

Hydraulic Motors

Two hydraulic motors are installed on the THS actuator. Each hydraulic motor is a fixed displacement type. The hydraulic fluid enters the pressure port and causes the rotating group to turn. The rotating group has nine pistons. These pistons move in their bores in the cylinder barrel when the cylinder turns. Turning of the cylinder barrel gives the necessary torque. The torque is transmitted through a splined drive shaft to the gear box of the THS actuator.

Pressure Off Brakes

Each hydraulic motor shaft has a POB. Each POB is located at the output shaft of their related hydraulic motor. The POB is a dry brake with a hydraulic release which is used to lock the shaft of the motor.

The shaft of the motor is locked 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.

Ball Screw Jack

The ball screw−jack is made up of the ball screw and the fail−safe ball nut. The fail−safe ball nut has three transport guides, a threaded fail−safe unit wiper and ice chipper. The mechanical input shaft limits the range of travel of the screw−jack.

A fail−safe tie bar goes through the center of the screw shaft and prevents axial separation of the screw shaft. The fail−safe ball screw−jack has two load paths.

The primary load path transmits the load and the secondary path stays free of any load. If the primary load path is axially separated, the secondary path takes the load and prevents damage to the ball screw−jack. Therefore the two ends continue to turn if the screw shaft is fractured.

Pitch Trim Actuator

The PTA (**P**itch **T**rim **A**ctuator) has:

Three brush-less motors, each with an electromagnetic clutch. In the normal mode, one clutch will be applied (energized) and the others de−clutched (de−energized). The output of the three motors is connected to move the input shaft through a reduction gear.

Three electronic sets, one to control each motor. The electronic sets also control the signal from the ELAC/SEC computers.

An override mechanism with three microswitches. It is installed downstream of the reduction gearbox. The override mechanism is connected mechanically to the input shaft.

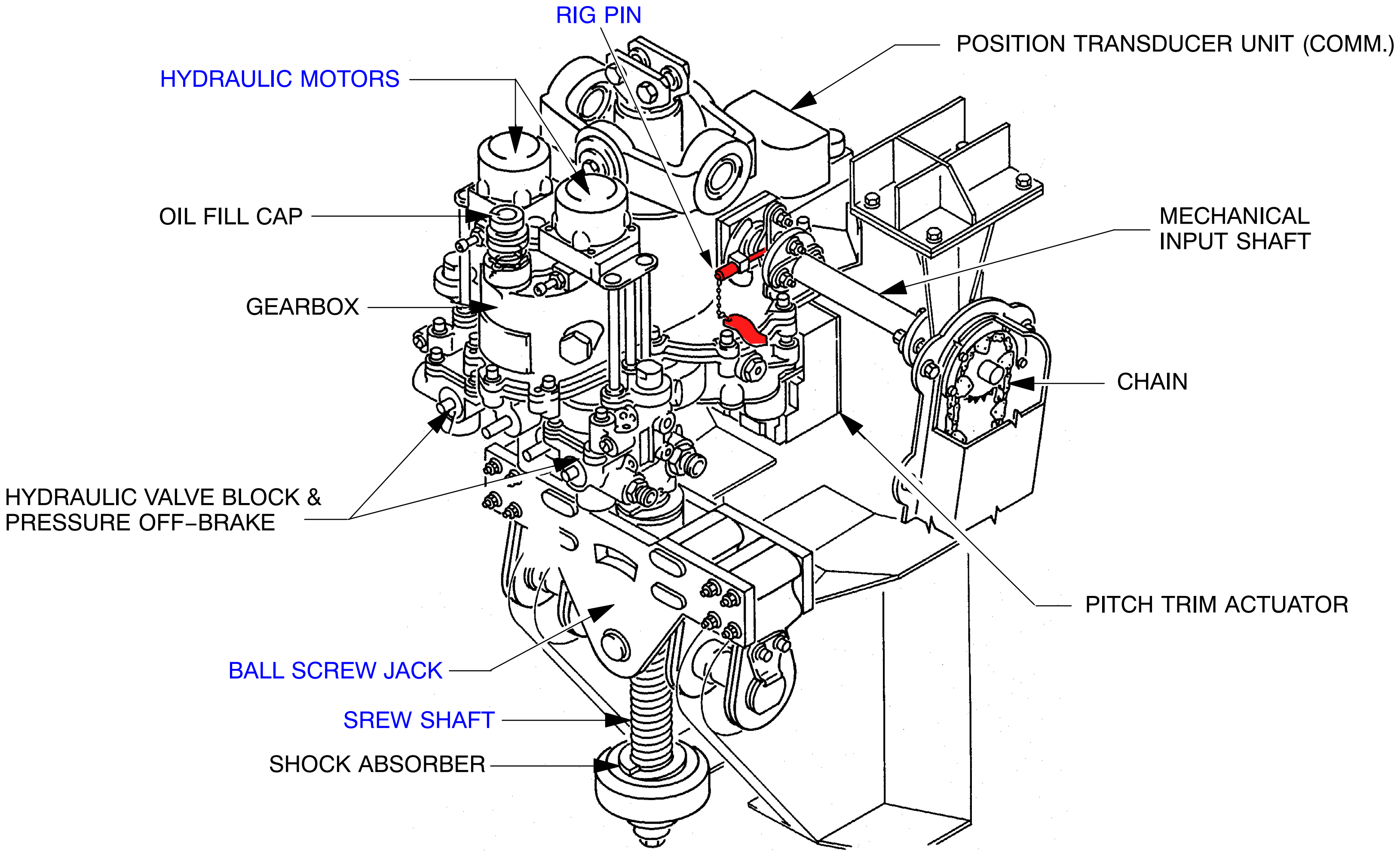


Figure 54 THS Actuator

THS ACTUATOR COMPONENT LOCATION

Gearbox

The gearbox is in a split housing. The two housing parts are referred to as the upper casing and the lower casing. The upper casing holds the screw and no−back housing assembly. It also supports the two hydraulic motors, the mechanical input lever and the control position transducer.

The lower casing supports:

- the PTA
- the monitor position transducer
- the two pressure−off brakes
- two hydraulic valve blocks
- the magnetic drain plug

The gearbox contains oil which is necessary to lubricate the internal components. The level of the oil can be checked visually through an oil level sight glass. The oil level sight glass is on the upper casing.

Borescope Plugs

Several borescope plugs on the gear box, makes it possible to inspect the gear box internally

- Valve−jamming protection system
- Pressure off brake
- No−back brake

Position Transducers

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 monitor position transducer is used to find the position of the ball screw.

No−Back System

The THS actuator has a no−back system that has a no−back brake which is of a ratchet and pawl type. The no−back brake holds the ball screw in its last position. It prevents movement of the ball screw under aerodynamic loads.

A no−back wear detection device in the form of an indicator (no−back wear indicator) is installed on the lower side of the gear box. The indicator has a cam roller which faces the top edge of the claw−stop. This finds the gap which agrees with the wear limit to be detected.

If a high wear occurs, a compressive external load causes the top claw−stop to move up to a higher position. This causes the top claw−stop to touch the cam roller of the indicator. In this case a red pop-out indicator is visible.

LRUs (Line Replaceable Units)

The Line Replaceable Units connected to the THS actuator are as follows:

- electronic control module of each of the electric motors
- pitch trim actuator
- position transducer packs
- filter
- hydraulic motors

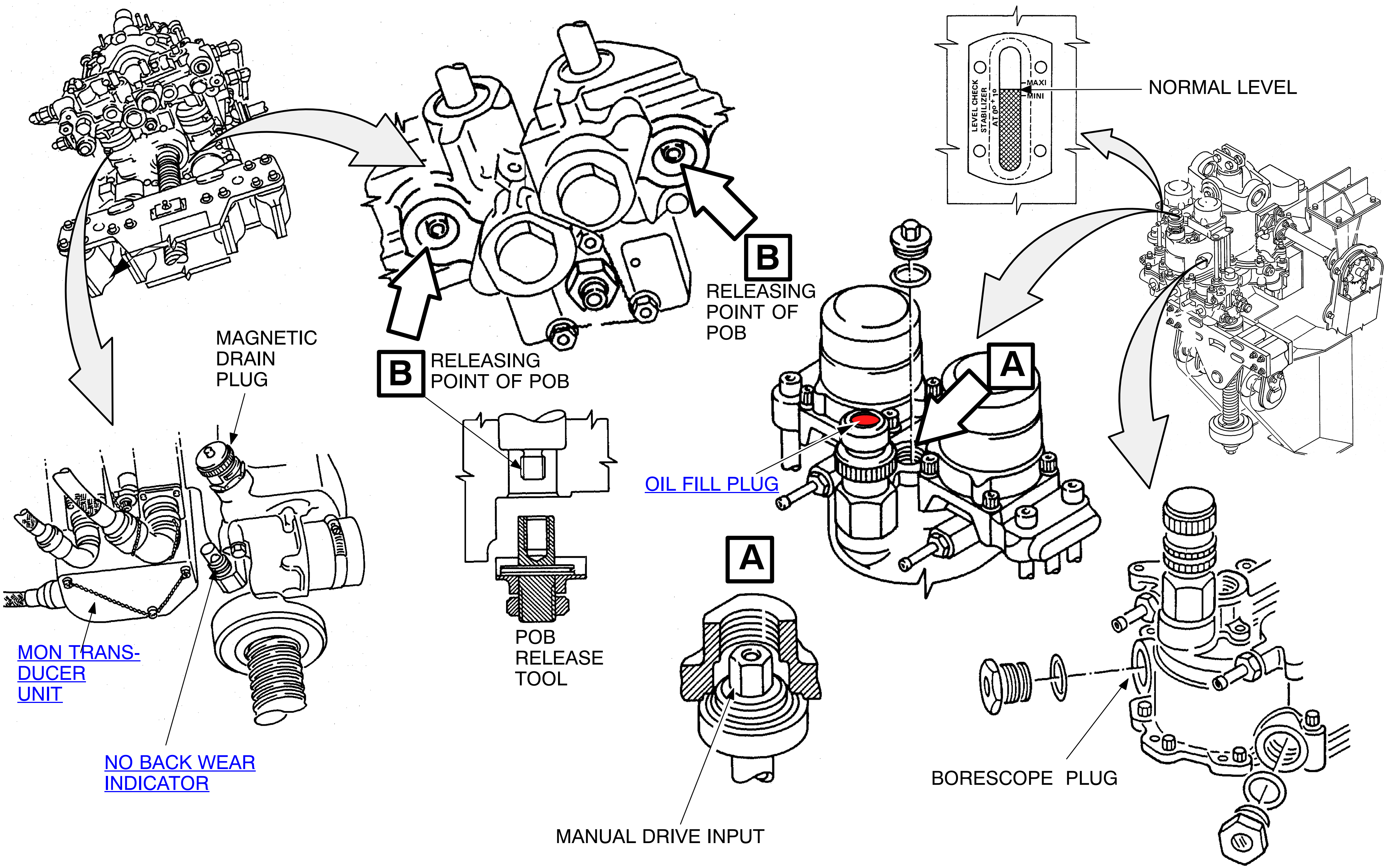


Figure 55 THS Actuator Components

THS ACTUATOR SYSTEM OPERATION

Hydraulic power from the green and yellow system is supplied through the valve blocks to the POB (**P**ressure **O**ff **B**rakes) of the two hydraulic motors. When the POB receives pressure it will release the brake and thereby the shaft of the hydraulic motor.

The active ELAC 2 will transmit the trim command to the electric motor #1. in the PTA. Each of the three brush-less motors in the PTA contains a electromagnetic clutch. The active motor will be energized and the two others at the same time de−energized.

The mechanical output from the motor via a reduction gear and a mechanical override mechanism, activate the control valves on both hydraulic motors in the same direction causing the motors to rotate and the stabilizer to move.

The feedback differential gear moves as the stabilizer changes position and will neutralize the input to the control valves. Claw type stops at both ends of the ball screw prevents mechanical overrun.

In case of blockage of one control valve, the detent will brake out and the comparator will stop the THS by engaging the POB on both motors, the system is identified as the valve−jamming protection system.

- prior the completion SB 25032K415 :The POB indicator pin will be extracted in case of the valve jamming protection system is activate. To reset the indicator the hydraulic pressure must be removed and the failure corrected.
- after the modification the POB indicator is removed

In case off loss of one hydraulic system, the POB of affected system will activate and the stabilizer will operate on half speed. In case of total loss of pressure the two POB and the no−back brake will activate, keeping the stabilizer in the last specified position.

Ground tests with hydraulic systems de−pressurized of the following can be done:

- valve jamming protection system
- pressure off brake
- no back brake

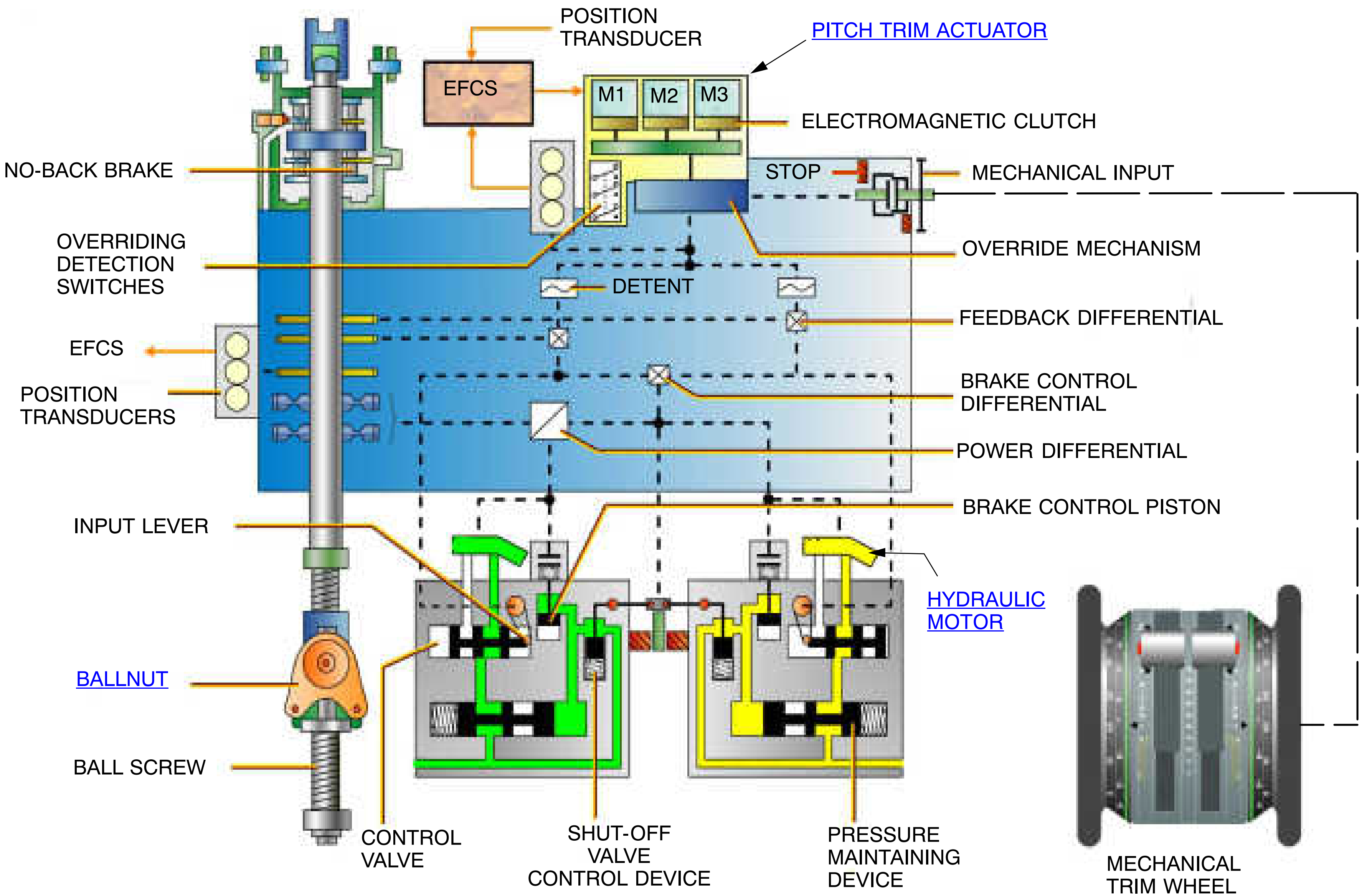


Figure 56 THS Control Schematic

27-95 FCDC SYSTEM

FLT CTL DATA CONCENTRATORS LAYOUT

General

Two FCDCs (**F**light **C**ontrol **D**ata **C**oncentrators) are installed in the EFCS. The purpose of the two FCDCs is to isolate, as far as possible, the ELACs and the SECs from downstream aircraft systems.

The FCDC receives and concentrate data from several sources such as:

- surface position
- T/O configuration warning
- mandatory parameters
- surface availability
- system status and warnings

The FCDC monitors and analysis the ELAC and SEC maintenance messages at power up, in flight and after touch down. **I**t concentrates and stores fault indications and deliver these information to the CFDIU on request.

Maintenance access for trouble shooting and EFCS tests is performed via the CFDS menu. The access to the EFCS is via the F/CTL obtained by selecting ”system report/test”. The CFDS will give advice and will also display the test result. For certain tests, the surface will operate.

Tests available via the CFDS are:

- elevator damping test
- aileron damping test
- spoiler LAF test (A320)
- aileron LAF test (A320)

Trouble shooting and tests of the FACs are performed via the FIDS (**F**ault **I**solation and **D**etection **S**ystem) built into FAC1. Access is via the ”AFS” on the CFDS menu.

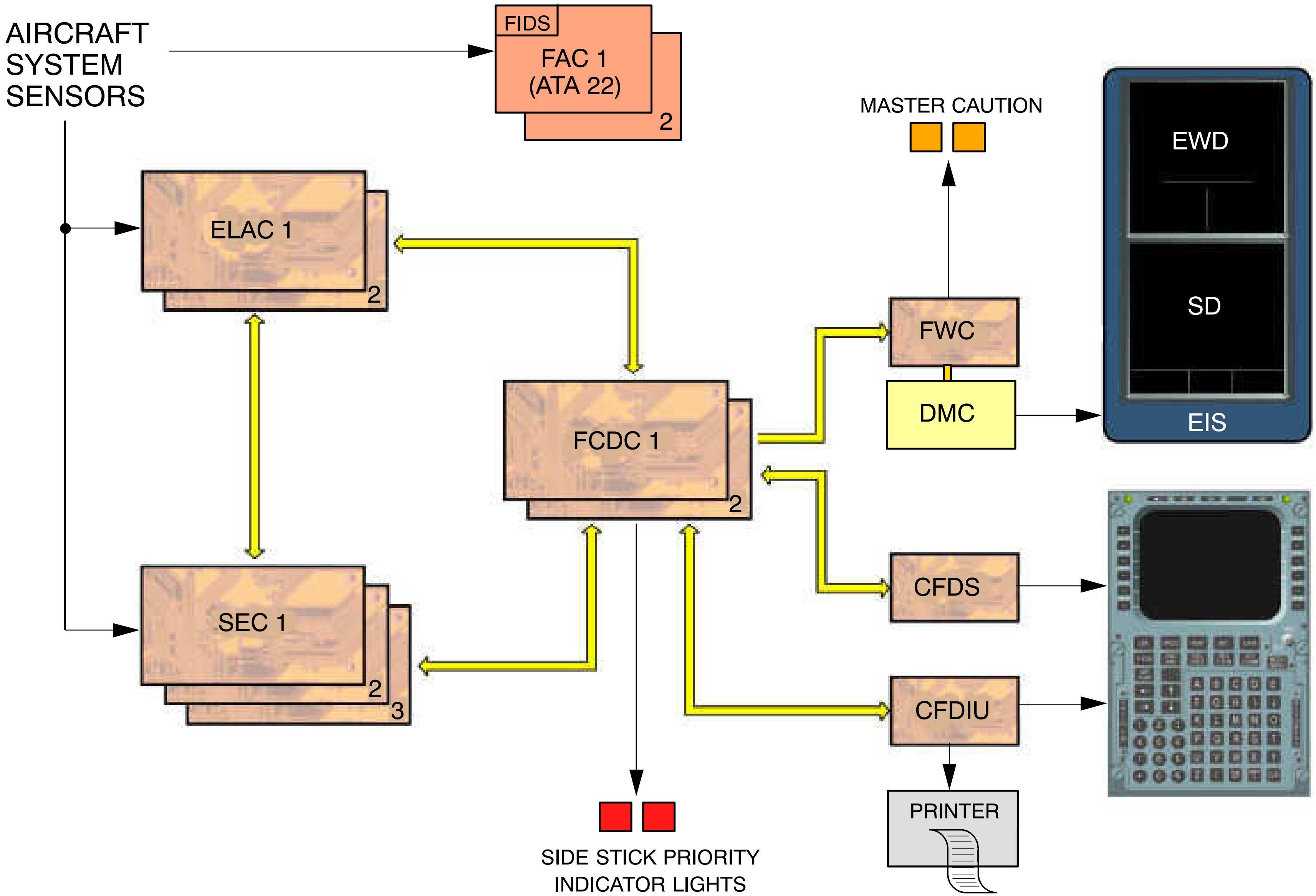


Figure 57 Flight Control Data Concentrators

27-96 MAINTENANCE AND SAFETY TESTS/BITE

EFCS MAINTENANCE SYSTEM

General

The EFCS maint. system is built around the two FCDCs which:

- collect the failures detected by the ELACS and the SECs
- consolidate the received data
- elaborate and generate the maintenance messages to the CFDIU.

There are three periodic tests launched by the CFDIU via the MCDU

- aileron servocontrol damping test
- elevator servocontrol damping test
- LAF test

Automatic Tests are built in order to detect hidden failures on standby channels and failures which cannot be detected by continuous monitoring.

For the CFDS (**C**entralized **F**ault **D**isplay **S**ystem) the FCDCs are type−1 systems i.e. their inputs/outputs are connected with the CFDIU (**C**entralized **F**ault **D**isplay **I**nterface **U**nit) by ARINC 429 buses.

The LRU failures detected in flight by the ELACs and the SECs are memorized by the FCDCs in non−volatile memories and are permanently transmitted to the CFDIU under label 356.

On the ground, using the MCDU (**M**ultipurpose **C**ontrol and **D**isplay **U**nit), the display in the cockpit of maintenance messages in clear language is effected according to two types:

- display specific to the CFDS for line maintenance
  (rapid trouble shooting).
- display specific to flight controls for deeper maintenance.

CFDS Menu

LAST LEG REPORT:

This function displays all the system failures which appeared the last flight.

The messages include:

- the failed LRU with ATA reference number
- the time of occurrence
- the date

PREVIOUS LEGS REPORT

The messages related to failures which appeared during the previous 64 flights include:

- the failed LRU with ATA reference number
- the time and date of occurrence
- the flight number

SYSTEM REPORT/TEST (Access Page to F/CTL)

This is the access to various systems and particularly F/CTL

F/CTL Menu

This menu is mainly provided for main−base maintenance of flight controls.

The 4 sub−menus below are displayed:

- EFCS 1 and EFCS 2
- SFCC 1 and SFCC 2

The EFCS maintenance messages are processed in the EFCS 1 or 2 sub−menus. These two sub−menus have the same constitution:

- LAST LEG REPORT
- PREVIOUS LEGS REPORT
- LRU IDENTIFICATION
- GROUND SCAN
- CLASS 3 FAULTS
- TEST
- MEMORY

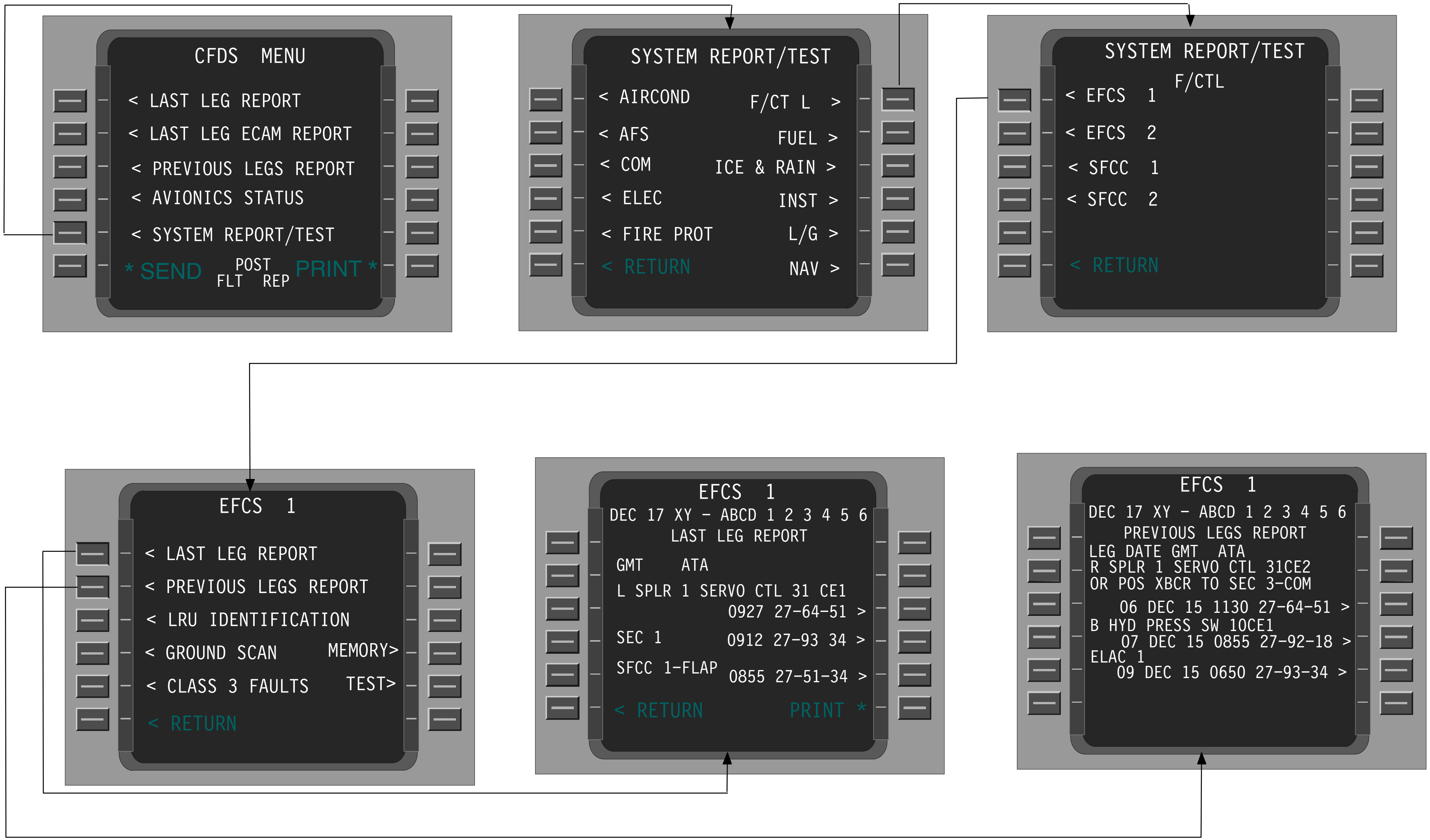


Figure 58 MCDU Utilization

02|−96|BITE|L2|B12

LAST LEG REPORT

Only the failures of the last flight, affecting flight controls are displayed.

These messages include:

- the date
- the aircraft identification,
- the flight number
- the time
- the failed LRU with its ATA reference

PREVIOUS LEGS REPORT

Only the failures of the last 64 flights, affecting flight controls are displayed.

The display is identical with that of CFDS menu.

TROUBLE SHOOTING DATA: EFCS STATUS

The TROUBLE SHOOTING DATA allows to display complementary fault information and data concerning the system status before and after the failure occurrence. This information is stored with each failure message.

The TROUBLE SHOOTING DATA can be called from the

- LAST LEG REPORT
- PREVIOUS LEG REPORT
  and
- GROUND REPORT

LRU IDENTIFICATION

This page indicates the part numbers of the flight control computers.

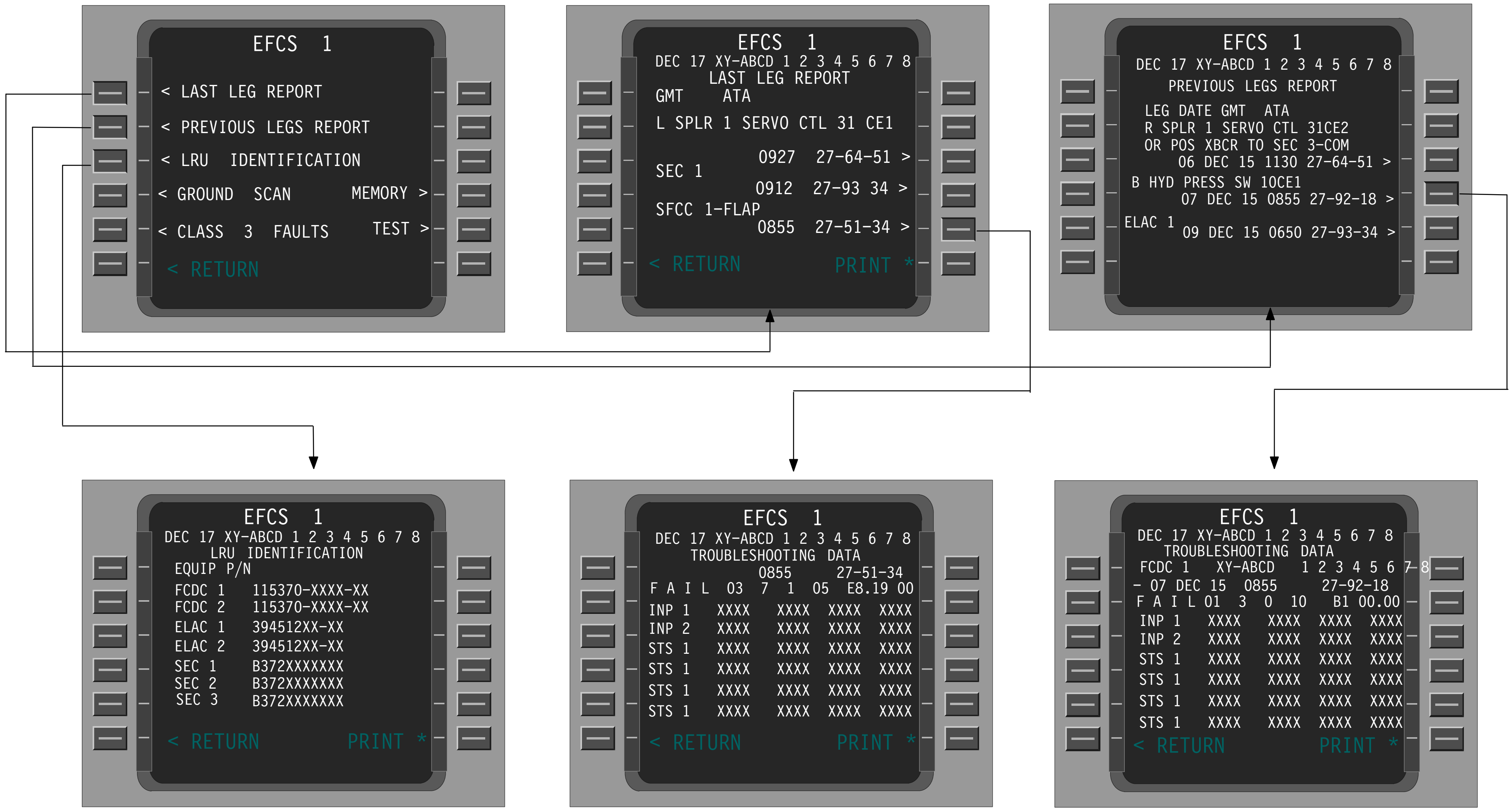


Figure 59 MCDU Utilization

GROUND SCAN

This function is used on the ground to display the failures which are present at the time of the request. Thus this function can confirm a troubleshooting.

MEMORY

The function MEMORY is used to read internal memories; it provides BITE data for shop use or information for the manufacturer.

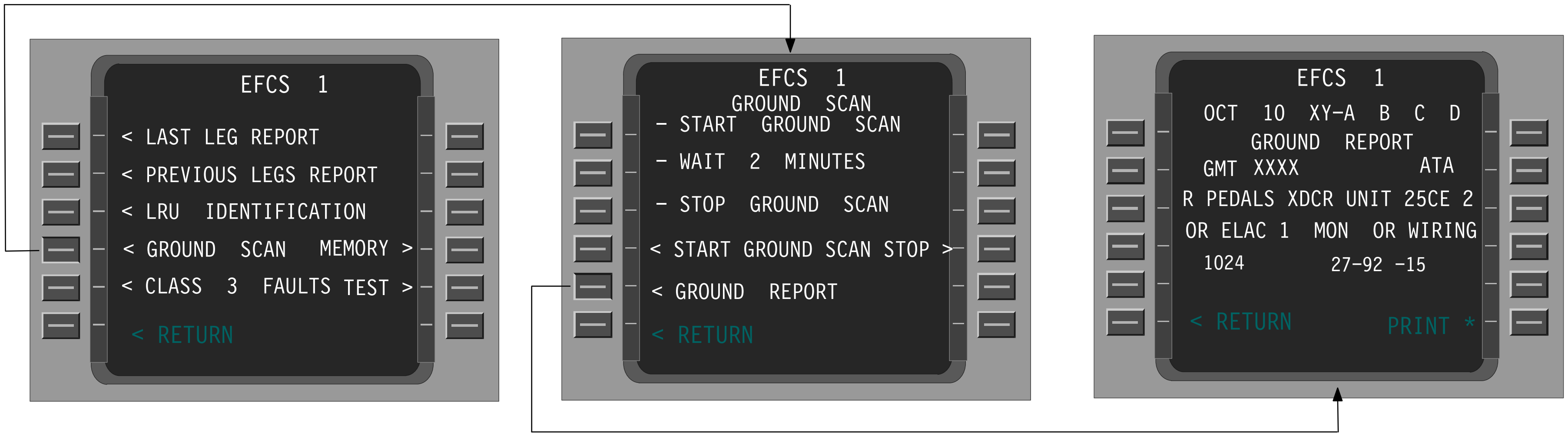


Figure 60 MCDU Utilization

EFCS MAINTENANCE SYSTEM (CON.)

TEST

This function is presented on the MCDU by the FCDCs. It has two purposes:

- initiate tests related to flight controls
- display the test results on the MCDU.

Three tests are available:

- elevator servocontrol damping test
- aileron servocontrol damping test
- LAF (**L**oad **A**lleviation **F**unction) test (if LAF installed).

Conditions required by the FCDC to initialize the test

For all tests Aircraft on ground and not moving condition:

- at least one ELAC and two SECs send ground condition
- LGCIU ”NOSE GEAR STATUS” wired signal is at compressed state
- “ENGINE PRESSURE STATUS” is at low state
- at least two SECs give ”WHEEL SPEED less than 6 KTS” information. no SEC sends ”WHEEL SPEED more than 66 KTS” information
- 3 hydraulic system pressure on:

  at least 3 computers (ELAC or SEC) send ”B, G, Y HIGH PRESSURE” information.

For aileron damping test and aileron LAF test :

- SEC1 & SEC2 P/BSW ”OFF”
- both ELACs OK

For elevator damping test and spoiler LAF test:

- ELAC1 & ELAC2 P/BSW ”OFF”
- SEC1 & SEC2 OK

Conditions required by ELAC to initialize test

- both ELAC’s available
- 3 hydraulic pressure available
- ground condition
- both side sticks at neutral
- wheel speed less than 6 KTS
- ADIRS switched off
- both FCDCs available

Conditions required by the SEC to initialize the test

- ground condition
- ADR OFF
- wheel speed < 6kts
- both FCDCs available

NOTE: When a test is not possible an hexa code is display on the MCDU in order to help the operator. When the FCDC is in MENUE mode. the FCDC FAULT warning is displayed on the upper ECAM.

Example:

ELEVATOR DAMPING TEST

This test is initiated from the MCDU: indications given by the MCDU provide guidance to conduct the test.

The test is controlled by the FCDC and is performed by the SEC1 and SEC2. The SECs control the deflections of the surfaces by pressurizing each servocontrol alternatively then simultaneously.

- If the test is possible

  For each movement, the FCDC memorizes a deflection speed and a pressure drop, then it detects a damping coefficient. The test result is displayed on the MCDU in the form L ELEV TEST OK or R ELEV TEST OK The value of the damping coefficient can be obtained and displayed through the TEST REPORT.

- If the test is not possible

  The test is displayed on the MCDU in the form ELEV TEST NOT POSSIBLE.

  The computer which have identified the anomaly, and the engagement condition code are displayed on the MCDU.

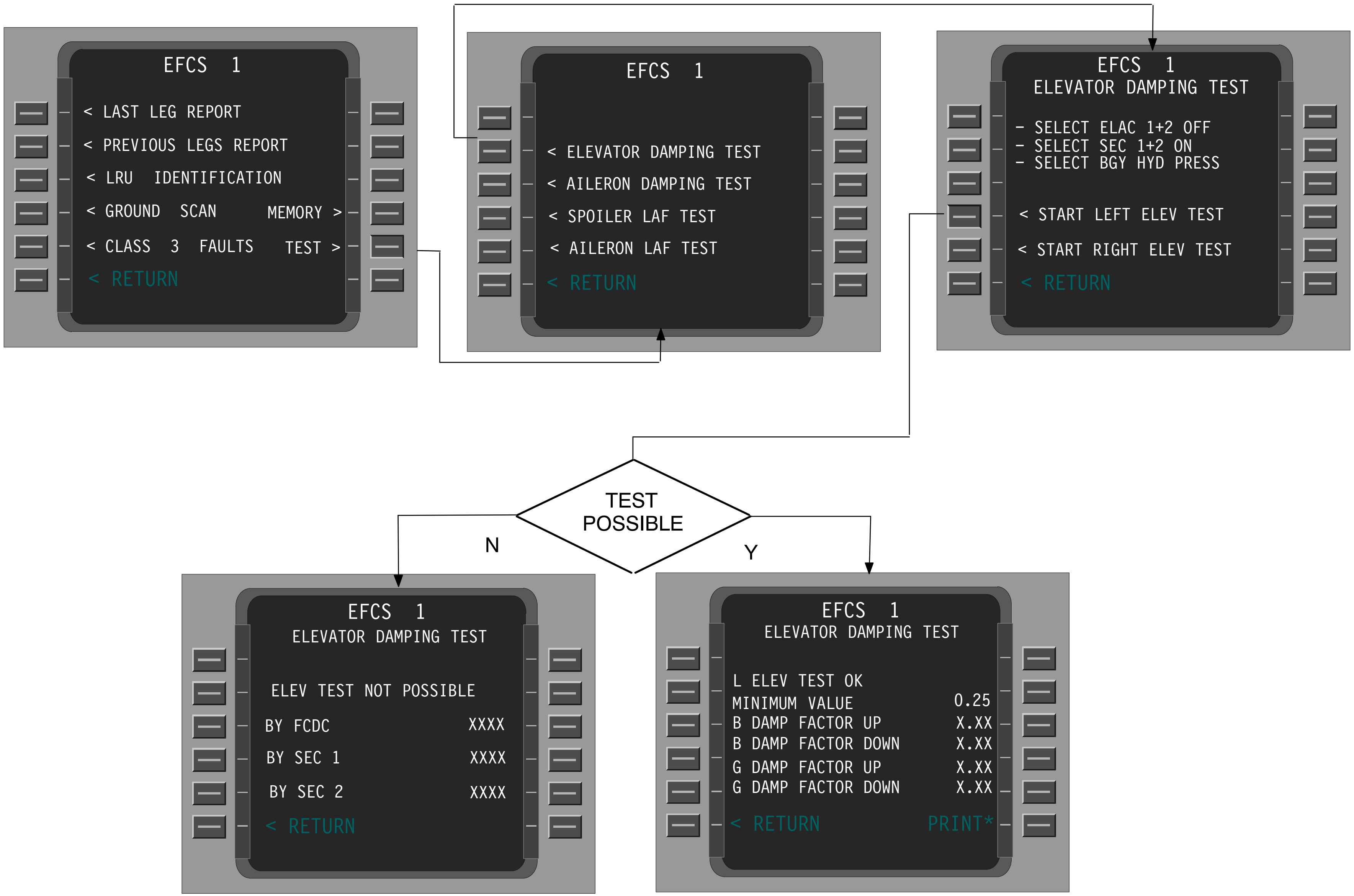


Figure 61 Test Example

AUTOMATIC TESTS

These tests are built in order to detect failures which are not seen by the permanent monitoring. Generally these tests are allowed when the aircraft is on ground and not moving.

THS Test

This test is performed by the ELACs and SECs when the aircraft is on ground and not moving.

The aim of this test is to check the capability of each computer to control either the THS electrical motor power supply switching or the THS enable signal. In case of unsuccessful test a warning "ELAC PITCH FAULT" (when an ELAC is affected) or a CLASS2 message (when a SEC is affected) and a specific maintenance message are displayed.

In addition the ground setting of the THS is normally ensured by the ELAC1 in order to check the availability of the ELAC1 THS control loop.

Aileron Changeover Test

This test is made only by the ELAC's. It is launched one time per flight in order to check that each ELAC is able to drive the aileron servocontrol mode (active or damped).The test is enabled when :

- the aircraft is on ground and not moving
- 3 hydraulic pressures are available
- the elevators are at neutral and it is stopped as soon as one of these conditions disappears. If case of unsuccessful test a warning"AIL SERVO FAULT" and a maintenance message will be displayed.

Elevator Test

Mechanical disconnection monitoring: This monitoring is ensured by the ELAC1 in order to check that its associated elevator servocontrols are not disconnected from the elevator.

If there is a disconnection, the failure is detected during the check and the warning "ELEV SERVO FAULT" and a maintenance message will be displayed.

Elevator Changeover Test

The conditions to launch this test are the same as for the aileron test.

Each ELAC checks its capability to drive the mode of the elevator servocontrol. Any failure will induce the loss of pitch control in the affected ELAC and the loss of elevator control in the associated SEC (if the SEC is affected by the failure).

This failure will give the warning "ELAC PITCH FAULT" or "ELEV SERVO FAULT" and a maintenance message.

Spoiler Servovalve Relay Test

The monitoring of the relay is made by the reading of the normally-closed contact status:

- when hydraulic pressure is high, the relays are closed
- when hydraulic pressure is low, the relays are open.

If a discrepancy is detected, the affected SEC disconnects. This failure will give "SEC FAULT" warning.

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27−50/80 FLAPS/SLATS

FLAPS/SLATS SYSTEM PRESENTATION

NOTE: Since the basic functions in the slat and flap systems are identical in many ways they are mostly described in the flap system and only shown in the slat system.

General

The high−lift system on each wing includes:

- two trailing edge flaps (outboard and inboard),
- five leading edge slats.

ATTENTION: On A321 the inboard and outboard flap each have tabs attached to their trailing edge.

Two SFCC 1 and SFCC 2 (**S**lat/**F**lap **C**ontrol **C**omputers) control the flap mechanism. The computers also monitor and test the system.

Fail−safe carriages, which roll freely on straight tracks, hold each flap. The tracks are installed on beams below the wing torque box. Plug−in rotary actuators move a mechanical transmission system which moves the flaps. An electrically controlled hydro−mechanical PCU (**P**ower **C**ontrol **U**nit) gives power to move the transmission.

A flap connection strut connects the adjacent inboard and outboard flap ends. Attached to the flap connection strut are flap disconnect sensors. The sensors send signals to stop the flap movement, if the strut movement is more than the specified limits.

A IPPU (**I**nstrumentation **P**osition **P**ick−Off **U**nit) shows the position of the flaps to the FWC. A **F**eedback **P**osition **P**ick−Off **U**nit (FPPU) gives signals of the output shaft position of the PCU. The **E**lectronic **C**entralized **A**ircraft **M**onitoring (ECAM) display unit shows the flap position.

Two APPU (**A**symmetry **P**osition **P**ick−Off **U**nits) give signals of flap position or speed. SFCC1 and SFCC2 receive and monitor the signals from the FPPU and the APPU.

Monitoring

The electrical control and monitoring system of the flaps includes:

- a **C**ommand **S**ensor **U**nit (CSU) installed in the cockpit.
- a slat/flap control lever, installed on the center pedestal, operates the CSU,
- SFCC1 and SFCC2 installed in the electronics compartment,
- an FPPU installed on the PCU
- two valve blocks as part of the PCU
- two APPUs installed in the transmission system

SFCC1 and SFCC2 use the data supplied to find:

- asymmetry
- runaway
- uncommanded movement
- overspeed

Flap Tabs (A321 only)

The tabs are attached to the rear spar of the inboard and the outboard flaps by hinges. They are operated by control rods connected to the hinge 1A mechanism and to the track 2, 3 and 4 roller carriages. A fairing covers each track and hinge.

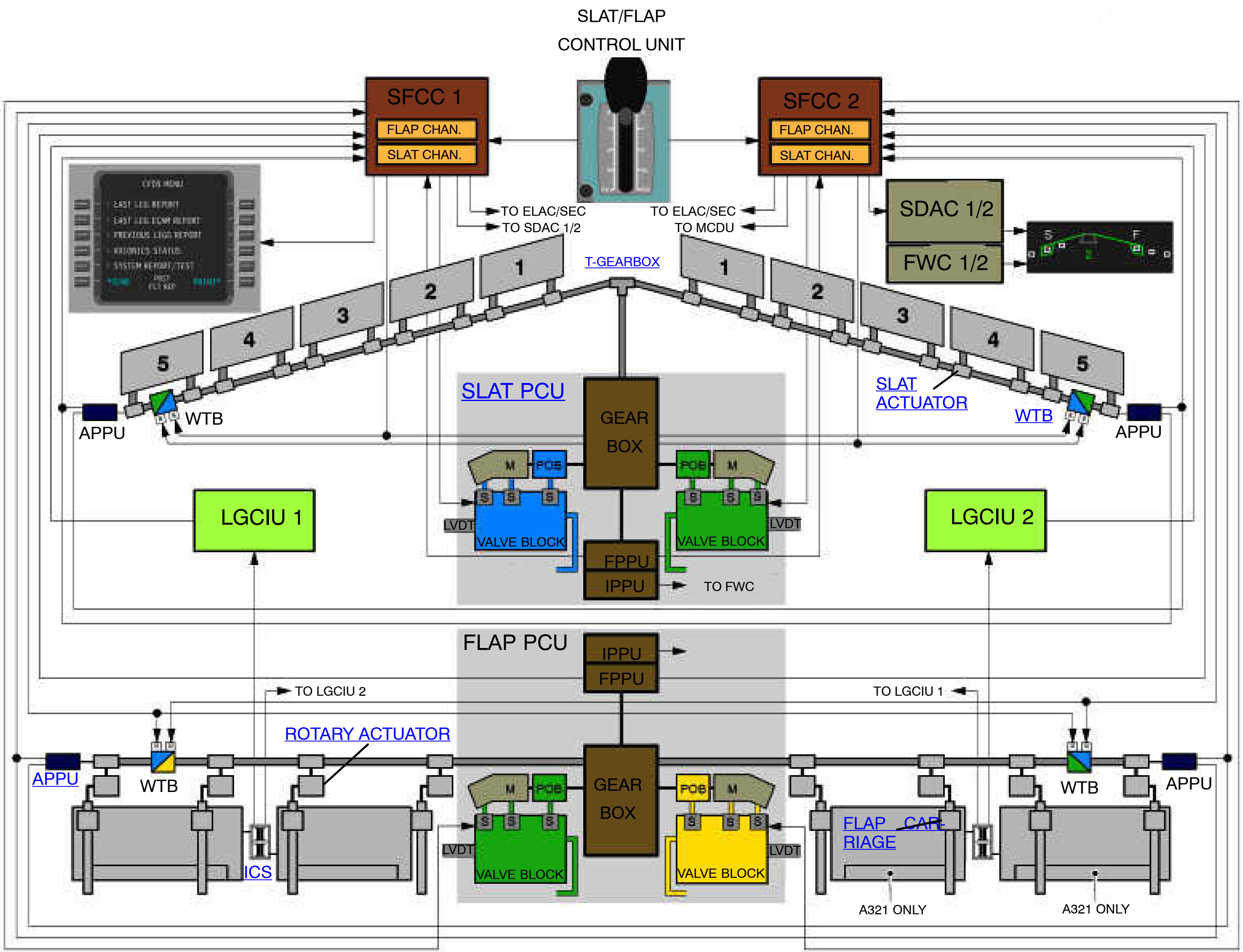


Figure 62 Flaps/Slats Sys. Schematic

Mechanical and Electrical Control

Operation of the slat/flap control lever gives mechanical control of the flaps. The CSU receives the mechanical movement of the control lever. The CSU changes this mechanical input into an electrical,position demand, output signal. SFCC1 and SFCC2 receive and compare the position signals which the CSU and FPPU send.

The PCU valve blocks receive drive command signals from SFCC1 and SFCC2. The PCU valve blocks start the hydraulic action.

SFCC1 and SFCC2 make a continuous control of the flap system. SFCC1 and SFCC2 keep failure data in the memories and transmit this data to the Centralized Fault Display System (CFDS). Built in Test Equipment (BITE) controls the correct function of SFCC1 and SFCC2.

The proximity switches of the FLAP disconnect detection system send signals to the Landing Gear Control Interface Units (LGCIU). The LGCIU send this signals to SFCC1 and SFCC2.

If too much flap movement is found, then the conditions listed below occur:

- the flap PCU is switched off
- a warning is sent to the flight crew.

Flap/Slat Position Indication

The slats / flaps position is continuously displayed on the upper ECAM, the E/W display.

Installed on each PCU is an FPPU which supplies flap or slat position data to the SFCCs An IPPU gives data to the flight data recorder and the Flight Warning System.

Hydraulic Actuation and Power Transmission

Two hydraulic motors in the PCU give hydraulic actuation. Each hydraulic motor gets power from a different hydraulic system, green or yellow.

Each hydraulic motor has its own valve block and Pressure−Off Brake (POB). The valve blocks control the direction of rotation and the speed of the output shafts of the PCU. The two hydraulic motors move the transmission system through a differential gearbox. This causes the flap control surfaces to move to the set position.

It is possible to operate the flap system, at half speed, if the failure conditions listed below occur:

- loss of one electrical supply,
- loss of one hydraulic system,
- failure of one SFCC, or failure of one of a pair of electrical components,
- failure of one engine.

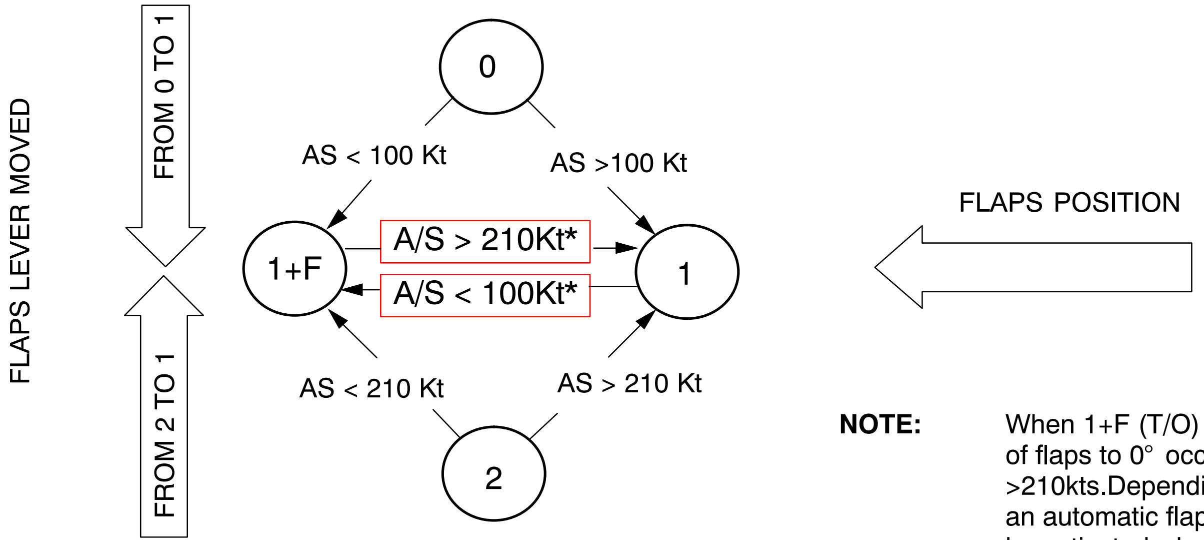
BITE Test

The flap system has a Built−In Test Equipment (BITE). You can do tests of the system through the Multipurpose Control and Display Unit (MCDU) in the cockpit.

The MCDU also indicates any failures in the system and gives trouble shooting data for the system. The two SFCC’s also do a BITE check on power−up.

Possible Flaps/Slats Positions

Position	SLATS	FLAPS	Indication on ECAM	
0	0	0		CRUISE, HOLD
1	18	0	1	HOLD
		10	1 + F	TAKE OFF
2	22	A 319 / 320 15 / A 321 14	2	TAKE OFF, APPR
3	22	A 319 / 320 20 / A 321 21	3	TAKE OFF, APPR, LDG
FULL	27	A320 / A 321 / A 319 35 / 25 / 40	FULL	LDG



NOTE: When 1+F (T/O) is selected, auto retraction of flaps to 0° occurs when speed >210kts.Depending on SFCC software status an automatic flap extension to 10 deg may be activated when in configuration 1 and A/C speed below 100kt.

Figure 63 Possible Flaps/Slats Positions Table

FLAPS/SLATS HYDRAULIC SUPPLY ARCHITECTURE

Description

The Flaps and Slats gets power from the hydraulic systems green,blue and yellow. Each PCU hydraulic motor and each side of the WTBs gets power from a different hydraulic system.

The blue hydraulic system supplies:

- one valve block on the slat PCU
- one side of each flap/slat WTB

The green hydraulic system supplies:

- one valve block on the flap and one on the slat PCU
- one side of both WTBs in the slat drive system
- one side of one WTB in the flap drive system

The yellow hydraulic system supplies:

- one valve block on the flap PCU
- one side of one WTB in the flap drive system

The architecture makes it possible to operate the surfaces on reduced speed in case of hydraulic system or slat/flap system malfunctions.

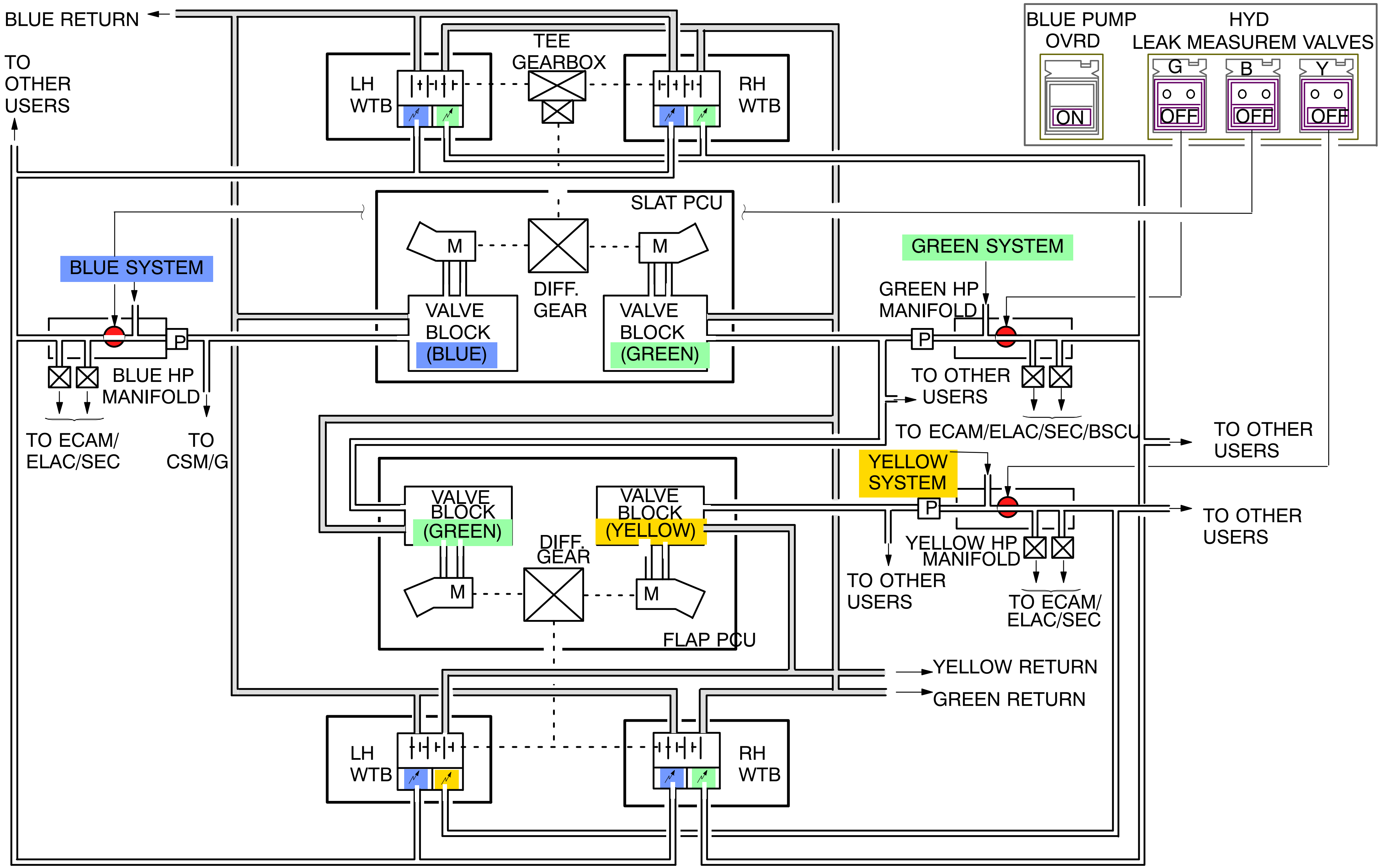


Figure 64 Flaps/Slats HYD Supply Schematic

27–51 FLAPS ELECTRICAL CONTROL

SLAT/FLAP CONTROL COMPUTER (SFCC) COMPONENT DESCRIPTION

General

ARINC 600 5 MCU cases contain the SFCC1 and the SFCC2. Each computer is the same and has two channels, one for the slats, the other one for the flaps. Each channel has two lanes (lane ONE and lane TWO) and include:

- one Power Supply Unit (PS)
- one lane 1 Processor/Input Module
- one lane 2 Processor Module
- one ARINC/Synchro Module
- one Output Module.

The slat and flap channels together, have one common services module. Each channel has its own 28V DC power unit. One 28V DC input supplies the two PSUs which have no relation between them. Each PSU supplies its channel with the necessary internal voltages.

The two lanes in each channel have different hardware and software:

- lane ONE has an INTEL 80C186 microprocessor (software programmed in Assembler language)
- lane TWO has a MOTOROLA 68HC000 microprocessor (software programmed in Pascal language).

The ARINC/Synchro Module has two functions:

- ARINC 429 Communications
- Synchro to digital conversion.

The Output Module has three functions:

- to collect and make an analysis of the data from lanes ONE and TWO
- provide output data to the related valve blocks
- to move data between lanes ONE and TWO through the dual–ported Random Access Memory (RAM) and a common non–volatile memory (EPROM).

The Common Services Module supplies:

- cross–channel communications through the RAM
- WTB logic
- system bus arbitration
- LVDT oscillator.

Each SFCC channel has an Installation–Coding input and an Operation Mode–Coding input.

The Installation–Coding enables the SFCC to identify position 1 or 2 installation.

The Operation Mode–Coding lets each channel find the difference between the operation modes related to aircraft versions:

- the flap operation mode 1 (relief enabled)
- the flap operation mode 2 (relief disabled)
- the slat operation mode 1
- the slat operation mode 2

The flap operation modes 1 and 2 are related to the flap relief function. This function operates when the aircraft is at the flap relief speed. At this speed the flap relief function signals the flaps to retract a small amount to prevent too much load on the flaps. Because the flap loads are less than the maximum permitted loads, all aircraft are in the flap operation mode 2 (relief disabled).

Pin programming disables/enables the flap relief function.

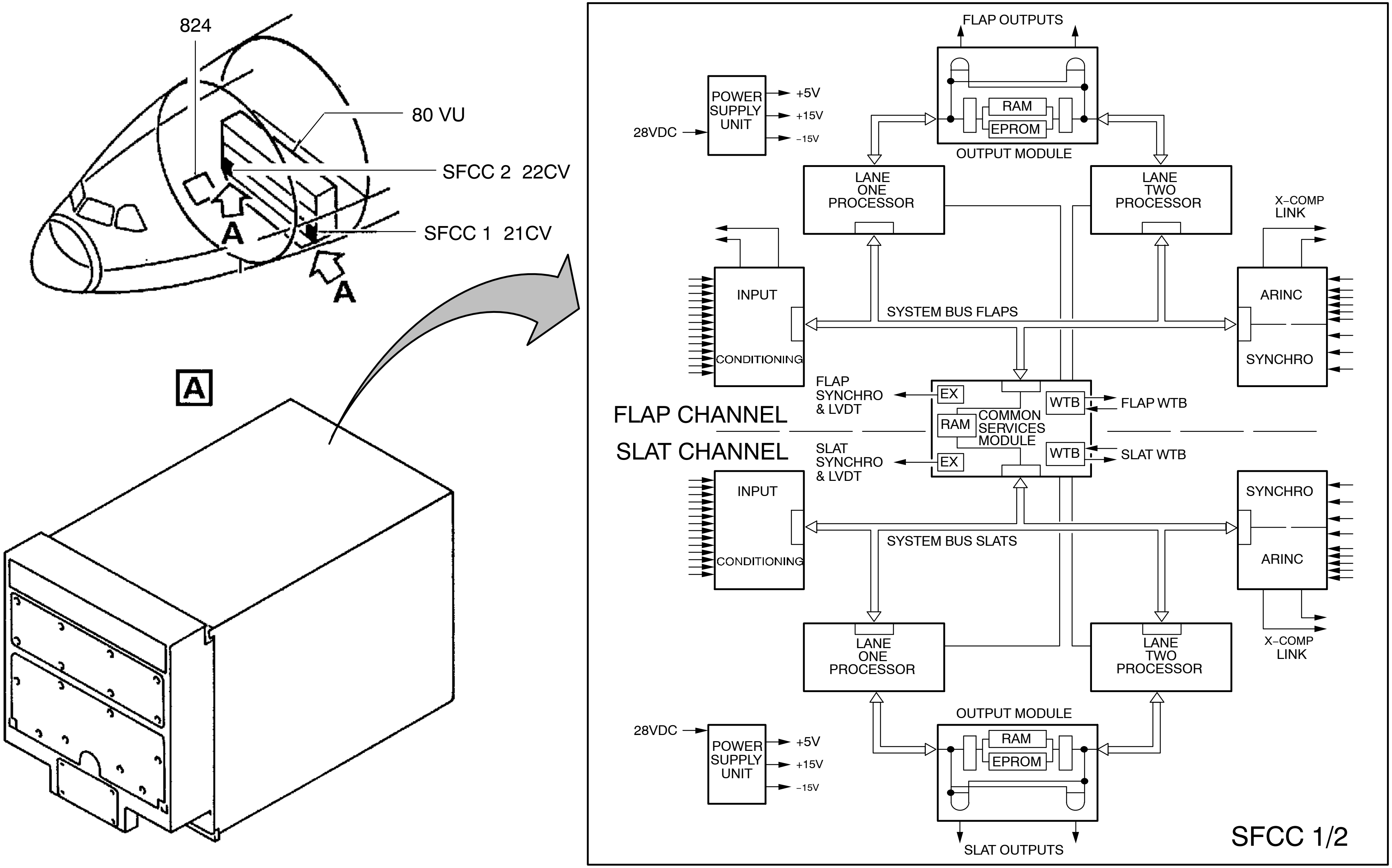


Figure 65 Slat/Flap Control Computer

POWER SUPPLY DISTRIBUTION

The electrical power supplies for the flap control and monitoring system are:

- the essential bus 401PP
- the normal bus 204PP
- the battery buses 701PP and 702PP.

The essential bus 401PP supplies:

- the SFCC 1 flap channel
- the related PCU solenoids
- the synchro and LVDT excitation voltages.

The battery bus 701PP supplies the WTB solenoids related to the SFCC 1.

The normal bus 204PP supplies:

- the SFCC 2 flap channel
- the related PCU solenoids
- the synchro and LVDT excitation voltages.

The battery bus 702PP supplies the WTB solenoids related to the SFCC 2. If the WTBs are operated, the battery buses keep the solenoids energized during a SFCC power failure.

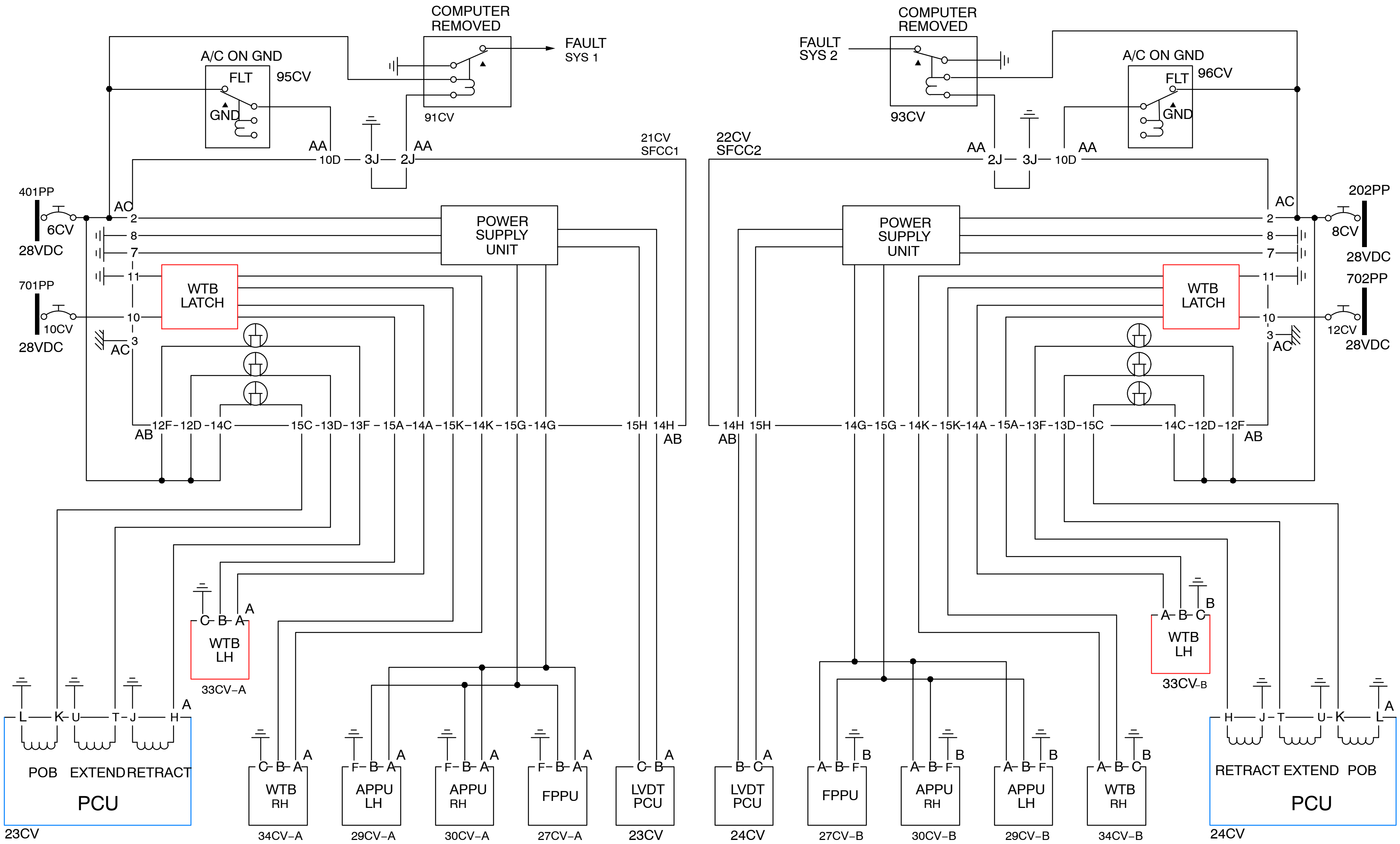


Figure 66 SFCC Flap Channel Power Supply

FLAP SYSTEM COMPONENTS – INTERFACES

The SFCCs send and receive discrete and analog electrical signals to and from the components of the flap system. Each SFCC has an ARINC 429 interface,which connects it to the other systems.

The slats/flaps surface position and system health are used by a number of other aircraft systems. Surface position is mainly used as definition of configuration.

For Example :

Flight Warning Computer (FWC) uses the IPPU position data for warning activation.

System Data Acquisition Concentrators (SDAC) receives ARINC data for ECAM display.

Elevator and Aileron Computers (ELAC) receives position data for flight control law selection.

Flight Augmentation Computer (FAC) uses the position data for flight envelope protection computation.

Spoiler Elevator Computers (SEC) uses the position data for the same purpose as the ELAC's due to the back–up function.

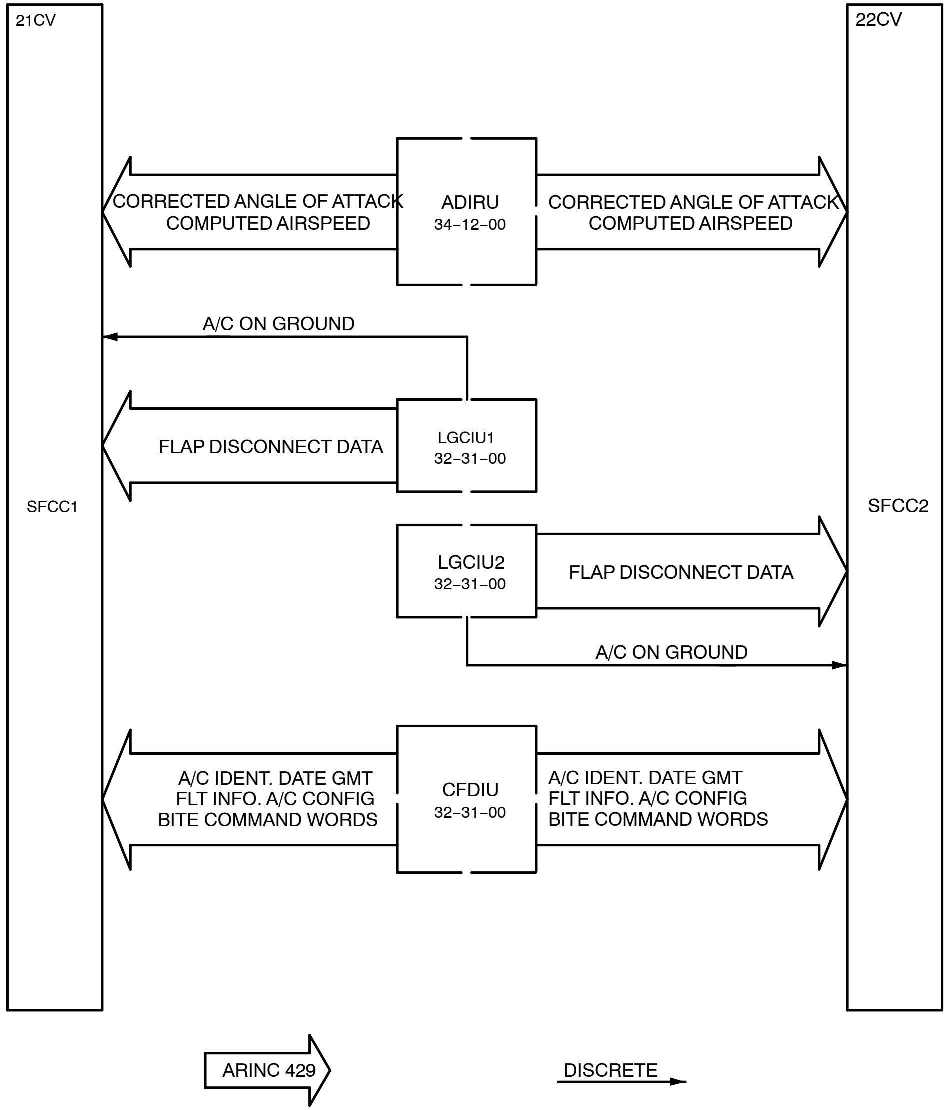
Centralized Fault Display Interface Unit (CFDIU) receives failure data and transmit bite commands.

Air Data Inertial Reference Unit (ADIRU) uses position data for Angle Of Attack (AOA) and static source correction.

Cabin Intercommunication system (CIDS) uses flap position discrete for automatic lighting of the cabin signs.

Engine Interface Unit (EIU) uses slat/flap lever position for minimum idle selection.

Ground Proximity Warning Computer (GPWS) uses flap position and the "FLAP 3" switch on overhead panel for landing config 3.



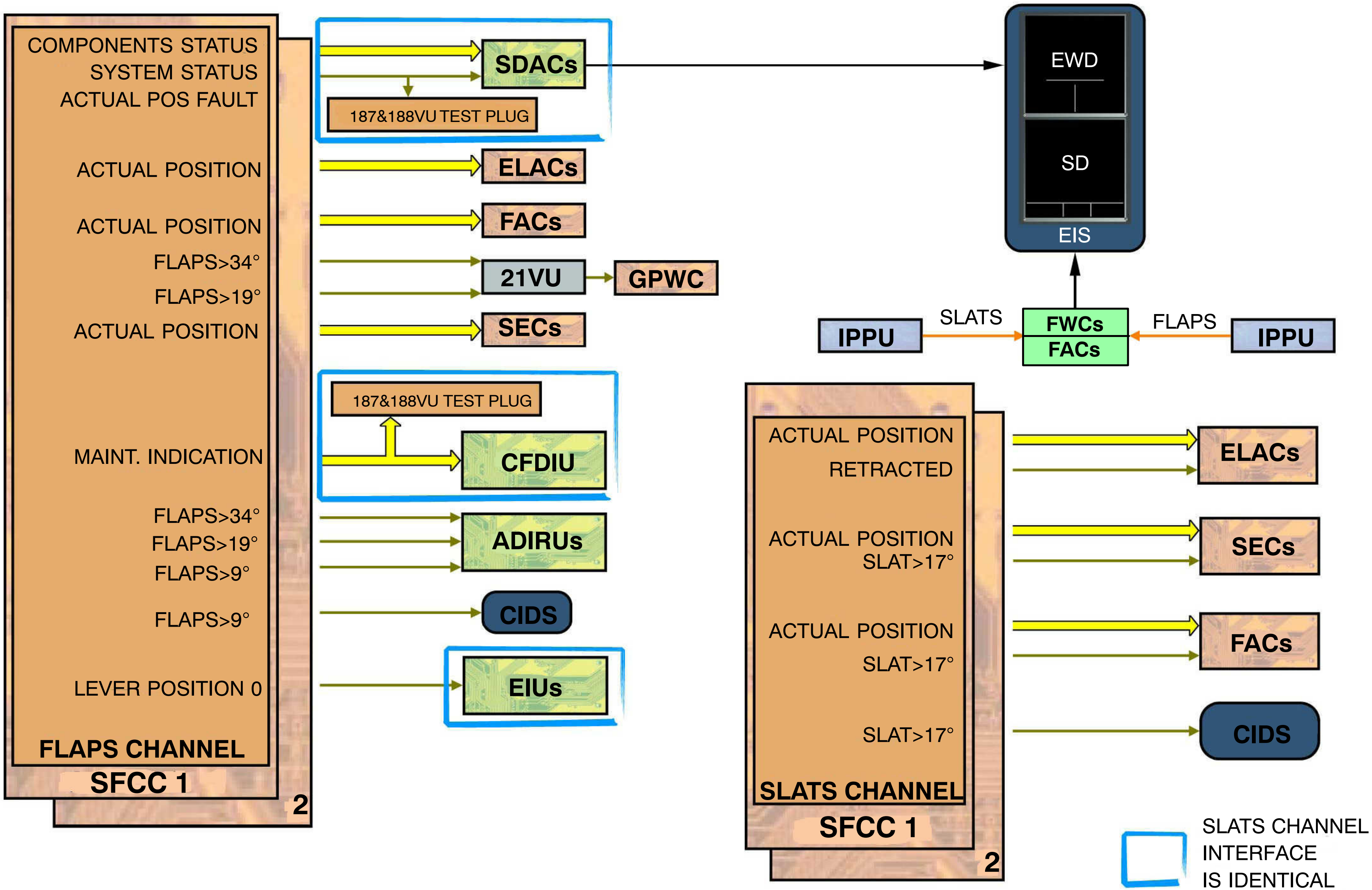


Figure 67 System Interfaces

COMMAND SENSOR UNIT & COMPONENTS

Slat/Flap Control Lever

The slat/flap control lever has:

- an attachment plate
- a housing
- a lever assembly
- a five-position gate.

The rectangular attachment plate has a slot for the movement of the lever assembly and connects to the center pedestal and the housing.

The housing contains:

- the CSU
- the lever assembly
- a pinion
- a five-position gate.

The lever assembly has a spring-loaded plunger, a quadrant that connects to the pinion and a knob with a collar. A pin at the lower end of the spring-loaded plunger engages in one of the notches of the five-position gate.

A baulk above the second and forth notches of the five-position gate stops a one-movement change of the lever position (from the 0 position to the FULL position).

When the collar is lifted (against the pressure of the spring-loaded plunger) the pin comes clear of the notch of the five-position gate. To move the lever past the baulk, the collar must be released.

As the lever moves from one position to the next the quadrant turns the pinion. The pinion turns the rotary switch of the CSU.

Command Sensor Unit

The CSU is a sealed unit which changes the mechanical signals from the slat/flap control lever to electrical signals. The CSU has:

- a housing
- a drive shaft
- four rotary switches
- a friction brake
- two electrical connectors.

The drive shaft has external splines, with one spline removed to give a master spline. There are two zero-marks, one on the end of the drive shaft and one on the housing. When the zero-marks are aligned, the CSU is at mechanical zero.

The drive shaft has a drive-gear which engages with the input gears of the rotary switches.

When the drive shaft turns, the four rotary switches are operated at the same time. Each rotary switch has a shaft with two sets of five tracks. The tracks give the same switching patterns as the switches turn. Each set of tracks has five detent patterns and four out-of-detent patterns.

The sliding contact connects two adjacent tracks to return for the detent patterns. For the out-of-detent patterns, the sliding contact connects only one of tracks 2, 3, 4 or 5 to return

The friction brake has a spring-loaded friction disc pack installed on the drive shaft of the CSU. The friction brake has two functions:

- to hold the CSU in the last set position after a drive shaft failure
- to apply friction to the drive shaft.

The rotary switches connect to two electrical connectors. Signals from one set of tracks on each switch go to connector A. Signals from the other set of tracks go to connector B.

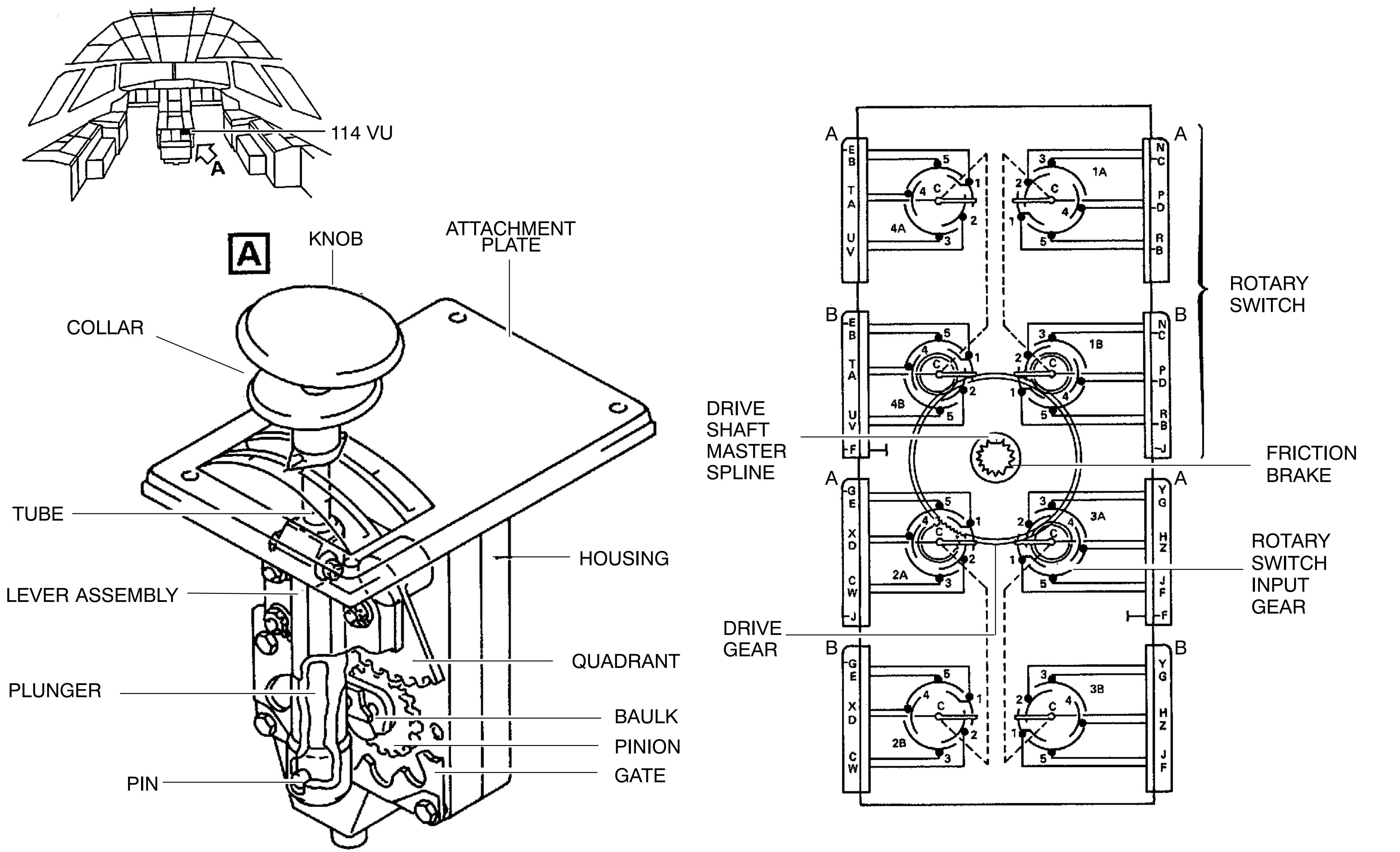


Figure 68 Command Sensor Unit

27–54/84 FLAPS/SLATS POWER TRANSMISSION

POWER CONTROL UNIT (PCU) & COMPONENTS

Flap/Slat Power Control Unit

A hydromechanical Power Control Unit (PCU) supplies the mechanical power to the flap transmission system. The PCU has two hydraulic motors with a Pressure–Off Brake (POB) and a valve block, which is electrically controlled. The main body contains a differential and a intermediate gearbox.

Line Replaceable Units (LRU) of the PCU are as follows:

- two hydraulic motors
- two Pressure–Off Brakes (POB)
- two valve blocks
- six solenoid valves
- two inlet filters
- two Linear Variable Differential Transducers (LVDT)
- one Feedback Position Pick–off Unit (FPPU)
- one Instrumentation Position Pick–off Unit (IPPU).

The flap and the slat PCU are identical and both are installed in the MLG wheel well.

1 Valve Block (2)

The flap PCU has two valve blocks which are electrically controlled. Each valve block controls the flow of hydraulic fluid to its related hydraulic motor and POB. The Linear Variable Differential Transducer (LVDT) is installed on one end of the valve block. The LVDT supplies a signal to the SFCC so that the SFCC can monitor the position of the control valve spool. Installed on the valve block opposite the LVDT are two directional solenoid valves and one POB solenoid valve.

The directional solenoid valves operate as the extend or the retract solenoid valves. The POB solenoid valve operates as the brake solenoid valve. The valve blocks are interchangeable with those fitted to the slat PCU. Removal of the valve blocks is possible without the removal of the PCU from the aircraft.

2 Hydraulic Motor (2)

Each multi–piston hydraulic motor receives hydraulic pressure from a valve block.

The output shaft of the motor is connected to a POB. Hydraulic fluid lubricates the motor. The cylinders of the motor are connected to two ports, referred to as the extend and retract ports.

When the valve block supplies hydraulic fluid to the extend port,the motor moves in the direction necessary to extend the flaps.

When hydraulic pressure is supplied to the retract port, the motor moves in the opposite direction and the flaps retract.

3 Pressure Off Brake

A POB is attached to each hydraulic motor. It 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.

The POB has a multiple friction–disk pack. Splines connect the stators to the POB casing and the rotors to the shaft in the center of the POB. Springs hold the friction disks together. When hydraulic pressure is applied to the POB, the friction disks are disengaged (against the pressure of the springs).To remove the POB, you must remove the related hydraulic motor first.

4 Differential Gearbox

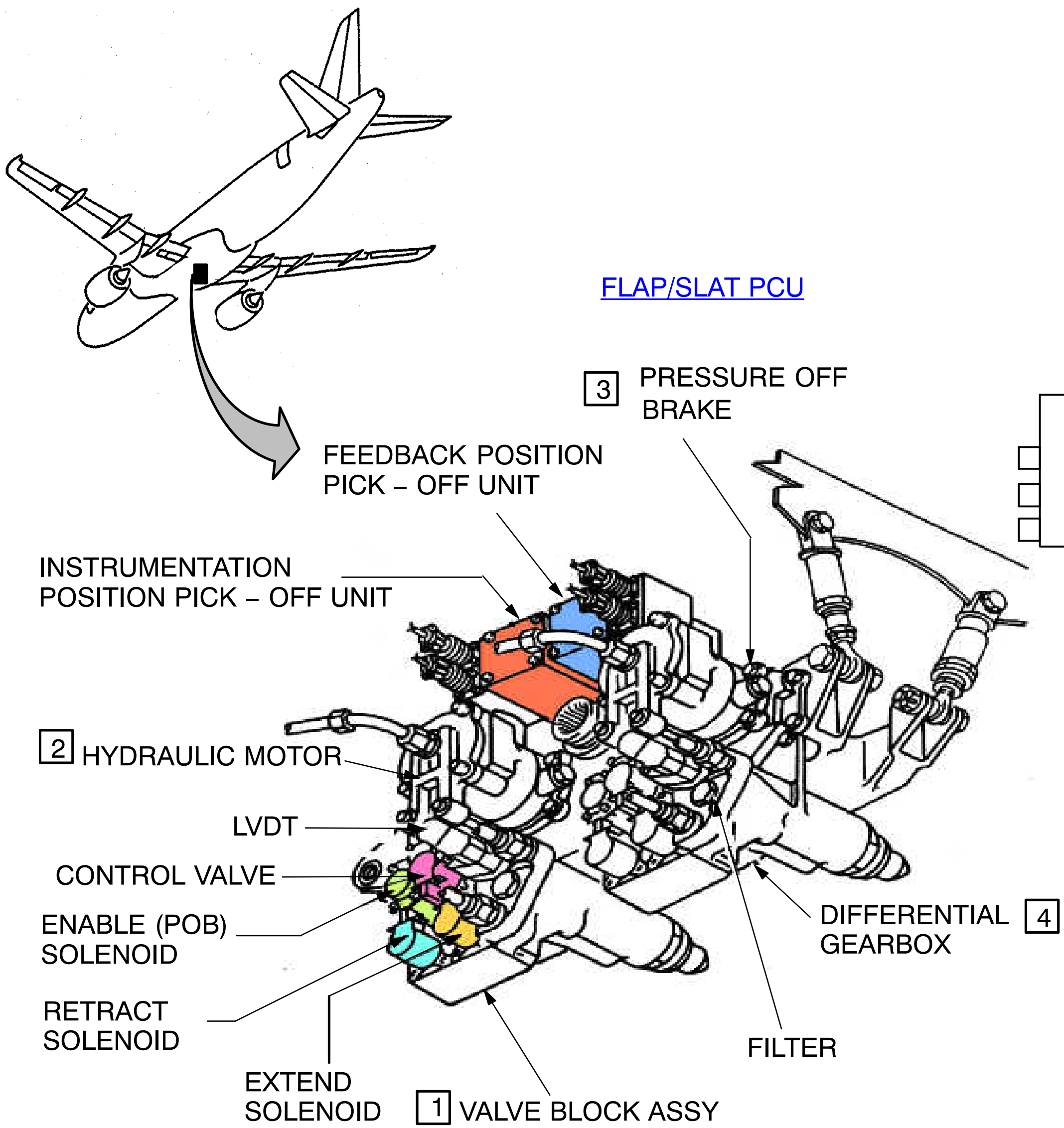
The differential gearbox contains a reduction and differential gear. The reduction and differential gear transmits the movement from the hydraulic motors through the PCU output bevel gear to the flap transmission system.

The casing of the differential gearbox also contains the intermediate gear which transmits the movement to the IPPU and the FPPU.

Solenoid Valve (6)

The solenoid valves of the PCU are the same and interchangeable with each other and those on the WTB. Their removal is possible without the removal of the valve blocks from the PCU.

FLAP/SLAT PCU



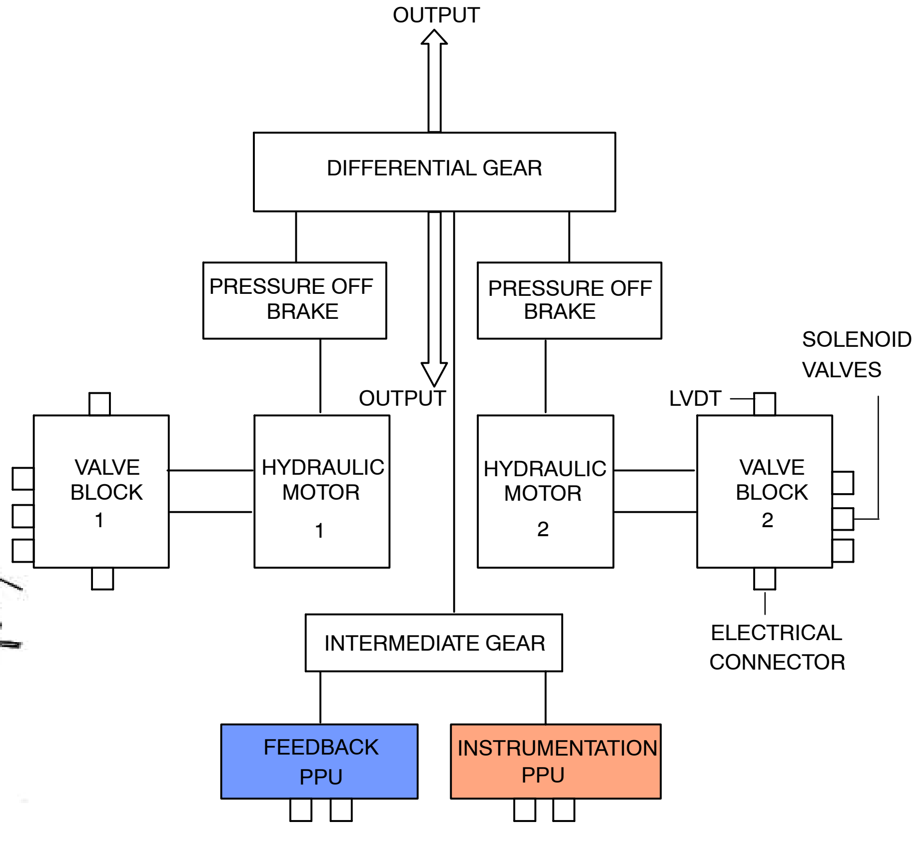


Figure 69 Flap/Slat PCU

PCU FUNCTIONAL OPERATION MODES

General Description

The signal from the SFCC's controls the PCU solenoid valves. Two solenoids function as directional control valves and the third solenoid allows hydraulic pressure for release of the POB.

The powered directional solenoid valve opens for hydraulic pressure to the POB and to the control valve spool. The direction of the spool and the quantity of movement controls the direction of the hydraulic motor rotation and the speed.

The multi piston hydraulic motor causes the differential gearbox to rotate. The differential gearbox permits flap or slat operation, at reduced speed, in case of computer or hydraulic failure.

Static Mode

The PCU can operate in static mode where all three solenoids are without power. Springs hold the control valve in neutral position and the spool valve closes for the hydraulic pressure and return lines, the POB and the end chambers of the spool valve are connected to return.

Full Speed Mode

In full speed mode one of the directional solenoid valves get power, the applicable end of the spool valve is pressurized and when the spool moves, the POB is pressurized, the POB solenoid valve is powered shortly after the directional solenoid. With the spool fully moved the hydraulic motor gets the maximum available hydraulic flow.

Low Speed Mode

The low speed mode is obtained immediately before the surfaces reaches the selected position. The second directional solenoid is powered causing the spool valve to move against neutral position and thereby limiting the flow to the motor. The rate of the spool movement is limited by the fluid restrictors.

When the transmission gets to the selected position the power to all three solenoids are removed causing the POB to engage, holding the transmission against the air load.

The force and the rate of the spool valve spring together with the port area/valve movement property gives a function that prevents the valve to close too rapid, causing the POB to engage due to pressure fluctuations. This can specially happen when hydraulic pressure is supplied by emergency or alternate pressure sources.

The loss of a single hydraulic system will cause the POB of the affected PCU motor to remain engaged. This locks one half of the differential gear. The serviceable motor will thus be able to operate the transmission on half speed.

A LVDT mounted on the end of the spool valve monitors the spool position and provide feed back to the SFCC.

Pressure Maintaining Function

Emergency or stand−by hydraulic power has a limited flow capacity. At a time of operation with emergency or stand−by hydraulic power, it is necessary to prevent a sudden decrease in supply pressure.

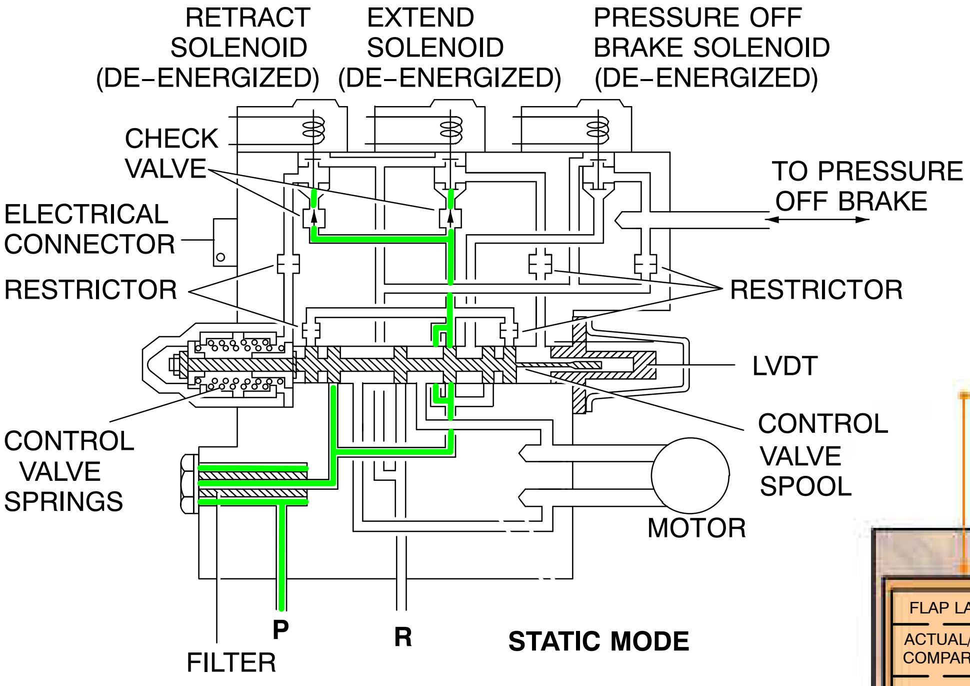
A sudden decrease in supply pressure can occur because of too much demand by the flap system. This could cause an application of the POB at any time.

The force and the rate of the spring, together with the port area/valve movement property, give the function that maintains the pressure of the valve. As the supply pressure decreases, the valve closes slowly. This reduces the flow rate to the motor and thus the work−load on the pump. This prevents the work−load of the slat / flap system to cause a sudden decrease of the supply pressure.

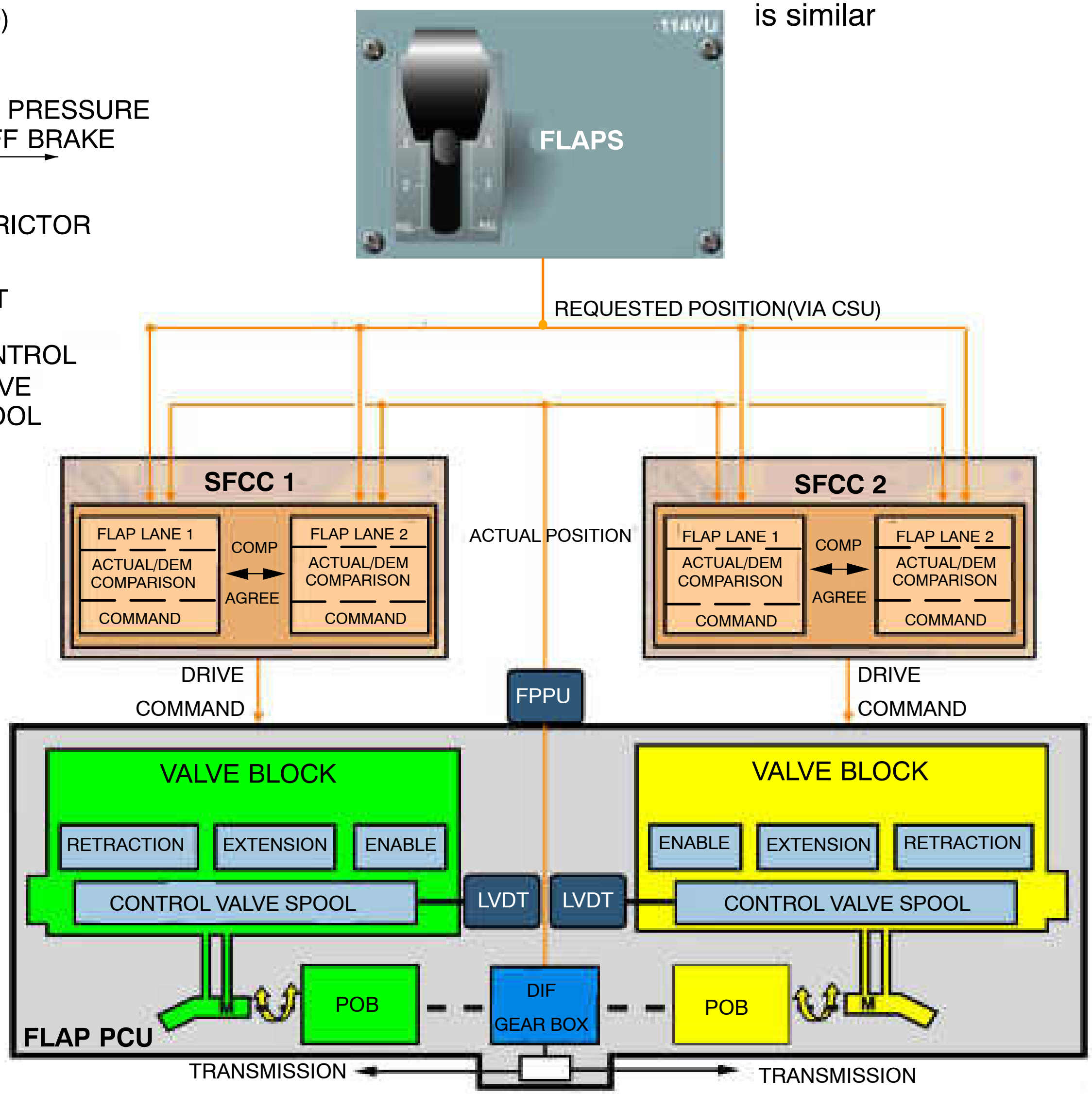
Single System Operation

The loss of the hydraulic pressure to one of the two motors causes the POB to apply and hold the motor output shaft. This locks one half of the differential gearbox. The serviceable motor then gives sufficient output torque at half speed, at the gearbox output shaft.

NOTE: Slat and Flap movement always obeys the last correct control lever movement. For example, when the lever moves from position 3 to FULL, the flaps will extend in the direction of the FULL position. If the lever returns to position 3 before the flaps reach position FULL, the direction of flap movement changes and the flaps move back to position 3.



FLAP PCU is shown
SLAT PCU function
is similar



FLAP/SLAT PCU MODES

Static Mode: All Solenoids De-Energized

Full Speed Mode: 1X Directional and Enable Solenoid Energized

Low Speed Mode: 2X Directional and Enable Solenoid Energized

Figure 70 PCU Control Modes

06|–54/84|PCU|L3|B1

27−54 FLAPS POWER TRANSMISSION

FLAPS MECHANICAL DRIVE PRESENTATION

Flap Transmission

The flap transmission system is routed in the trailing edge of the wing, from the flap PCU in the wheel well, to the outboard flap actuator assy.

The PCU output shaft rotates a torque shaft. Via gear boxes the torque shaft activate,s four flap actuators on each wing. The actuators transfer the rotary movement of the torque shaft to a linear movement of the flap carriage mechanism.

Located together with outboard actuator, number 4, on left and right wing is installed a Asymmetry Position Pick−off Unit (APPU), used in the flap protection system.

Also used in the flap protection system is the WTB. It is located between the actuator number 3 and 4 on left and right wing.

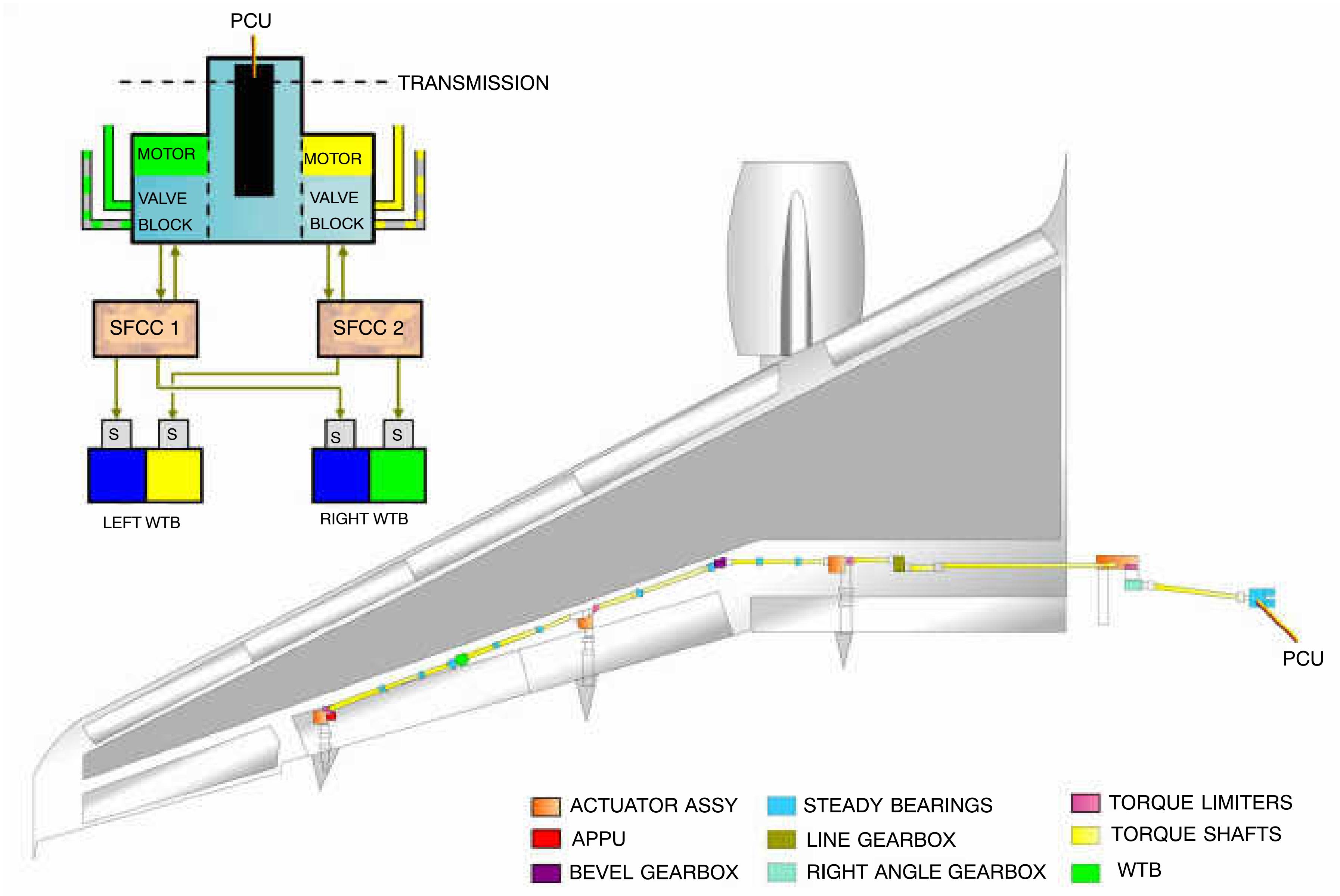


Figure 71 Flaps Components Location

Torque Shafts

The rotation of the torque shafts drives all gearboxes and rotary actuator input shafts simultaneously, at the same speed. The torque shafts are mounted with a Fixed (F) or Moveable (M) connection.

The end fittings have a flange for a bolted joint or splines for a sliding end connection. Bolts attach universal joints, plunging joints and splined movable joints to the flanges where necessary.

The universal joints permit large angular changes of alignment and the splined movable joints allow small angular changes of alignment. Each shaft has at least one sliding end connection. The sliding end connection has an indicator groove. This goes out of view when the connection engagement is below a specified minimum.

Steady bearings, attached to the structure, support the torque shafts where small angular changes of alignment are present.

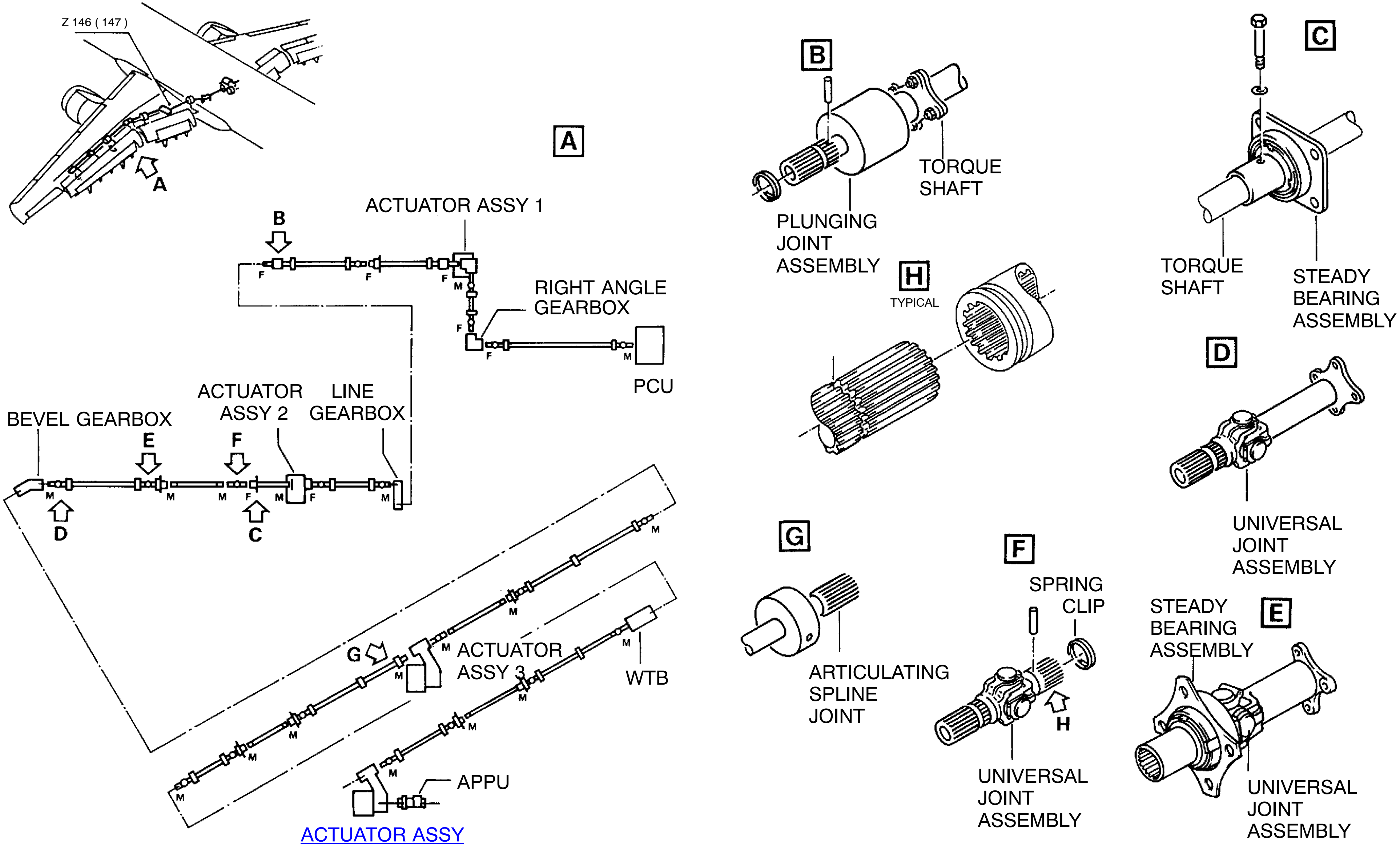


Figure 72 Torque Shafts

FLAPS MECHANICAL DRIVE COMPONENTS

Transmission Gear Boxes

Three types of one to one ratio gearboxes are used in the flap transmission where large changes in torque shaft alignment are present.

A right angle gearbox changes alignment through 90° for input to track 1 offset gearbox.

A line gearbox moves drive path onto the rear face of the rear false spar.

A 19° bevel gearbox aligns the drive with the rear spar.

The gear boxes are filled with grease. Lip seals on the input and output shafts is preventing unwanted material to enter the gear box. A plugged maintenance inspection hole are located in the bottom of the units.

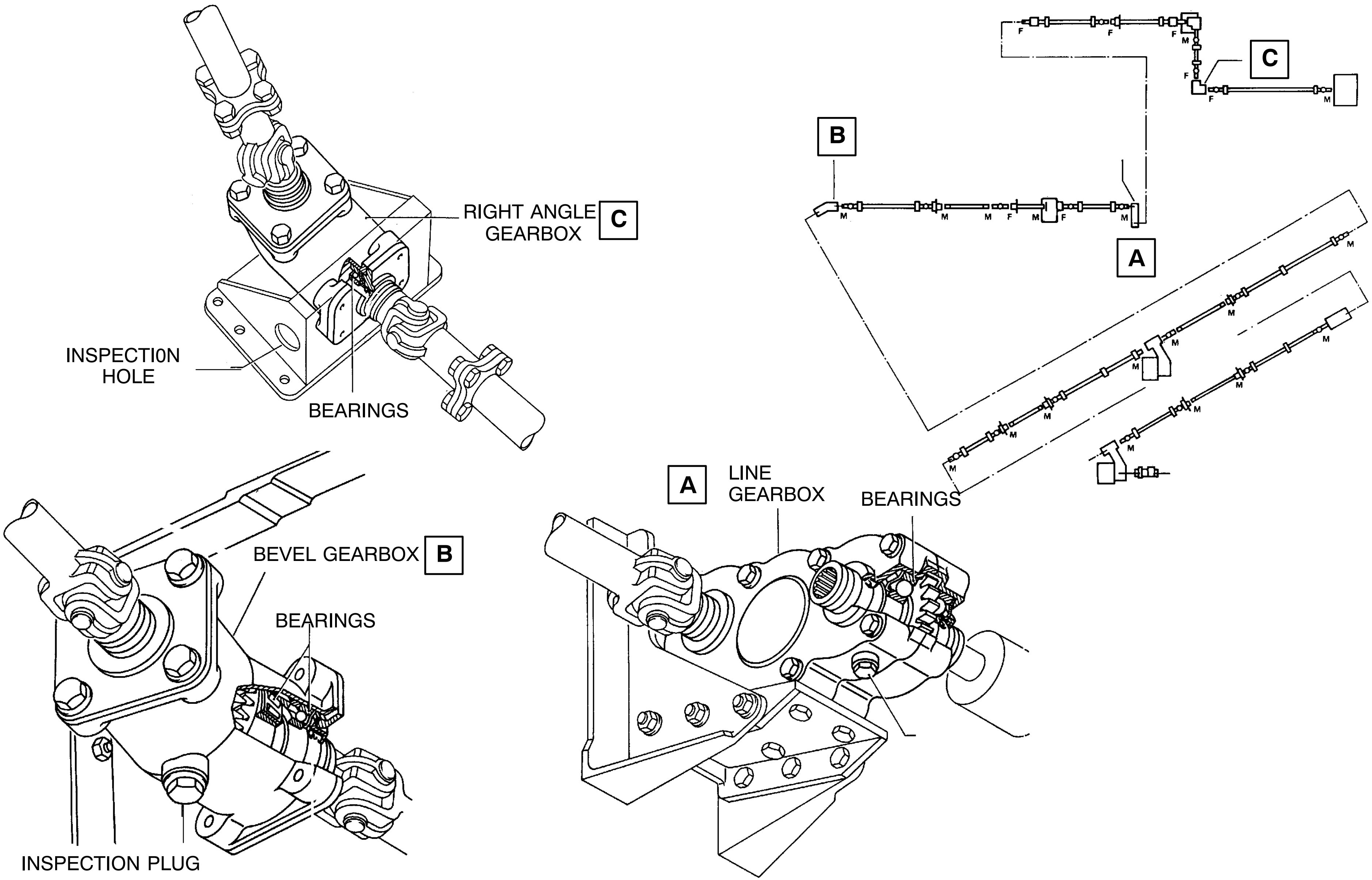


Figure 73 TRANSMISSION GEAR BOXES

Actuators

One actuator operates the flap mechanism at each track. It provides the torque and speed reduction necessary to drive the flap required rate.

Each actuator is driven by an offset gearbox which transmits power from the torque shaft to the plug−in rotary actuator.

The parts of the actuator are:

- an offset gearbox
- a plug−in rotary actuator.

The offset gearbox casing contains:

- a through shaft
- the torque limiter
- reduction gearing
- the rotary actuator.

The power goes from the torque shaft through the torque limiter to spur gears. The spur gears move the input shaft of the rotary actuator.

Torque Limiter

The torque limiter has:

- a ball ramp device
- a friction disk pack spline−mounted to release too much torque through the gearbox casing into the aircraft structure
- a spring disk pack that is set to a limit of a minimum of 120 % of the maxi mum torque for operation
- an indicator with a spring clip which usually stays in the retracted position.

The torque limiter is made to stop the transmission of too much torque into the output. It also makes sure that the indication of torque peaks, which momentarily engage and release the torque limiter, does not occur.

If the torque limiter responses, the system can be set again by operating in the opposite direction. The indicator stays extended until it is cancelled manually.

Bolts attach the rotary actuator to the offset gearbox casing. The gearbox output shaft turns the rotary actuator. A first−stage gear train transmits input torque from the offset gearbox to the power stage of the actuator.

The power stage includes nine planet gears held by rings. This gives an equal share of the load between the driven output carrier drive,and the earth annulus gear. The differential gear ratio between the planet gears, the earth annulus gear and the output ring gears gives a high torque/low speed output.

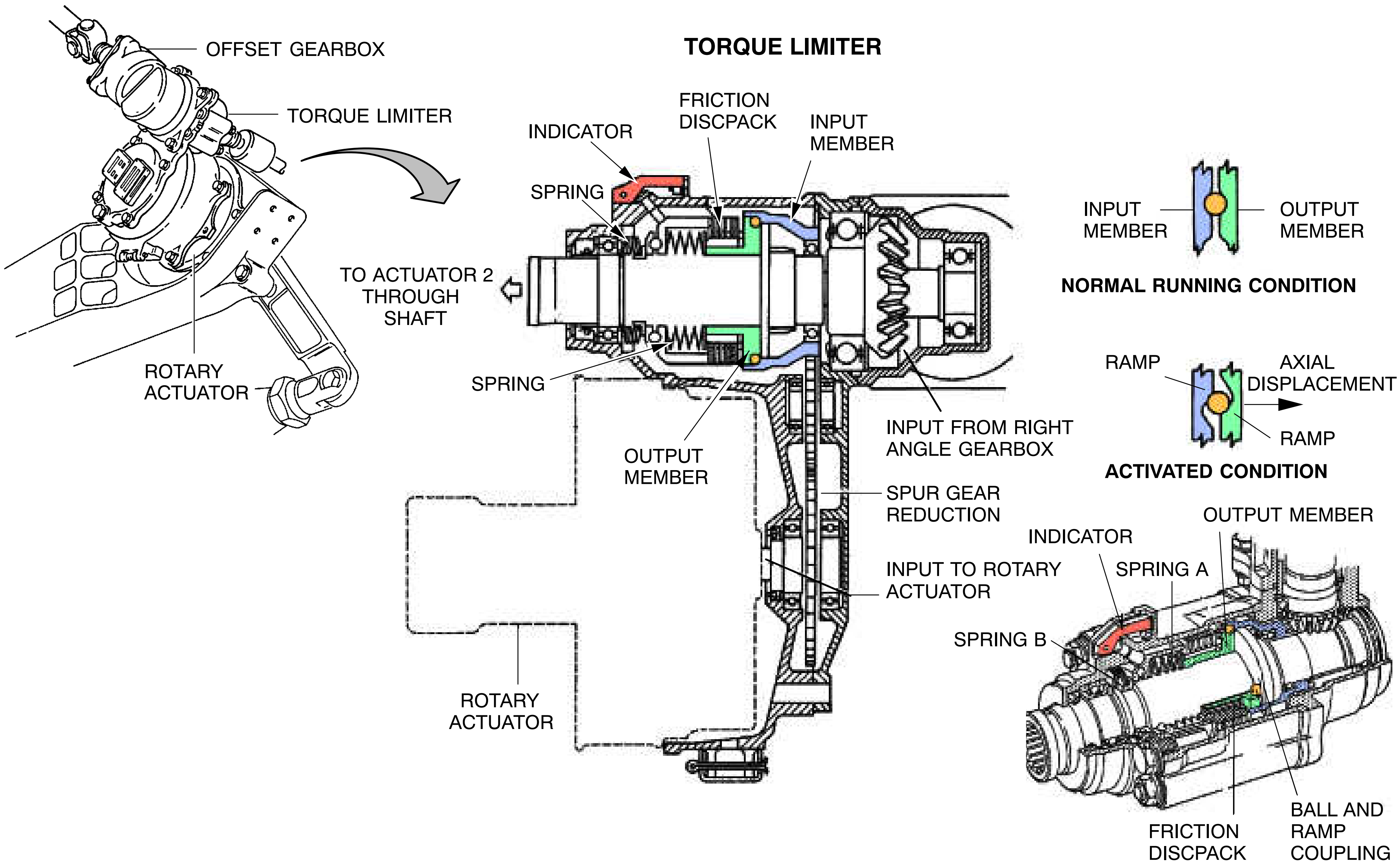


Figure 74 FLAP ACTUATOR & TORQUE LIMITER

Tracks & Carriages

Flaps are supported on carriages traveling on straight tracks.

Tracks 2, 3 and 4 are similar. Track installation is on beams below the wing. Track 1, attached to the fuselage, uses a different configuration.

Drive levers on the actuator output shafts move the flaps through flap link arms.

To prevent extension or retraction overtravel each drive lever has mechanical stops. Engagement of the stops does not occur at a time of normal operation.

The offset gearbox of the track 4 actuator drives an Asymmetry Position Pick−off Unit (APPU).

Carriages, which roll freely on staight tracks, hold each flap. Vertical−load rollers and side−load rollers keep the carriages on the tracks.

Each carriage has a containment device to hold it on the track if a failure occurs.

Attached to the flap bottom surface at tracks 2, 3 and 4 are brackets. Connected to the brackets is a linkage which operates the hinged part of the track fairing during flap extension and retraction.

At the end of each track are mechanical stops. The stops prevent retraction overtravel and make sure that the flaps do not disengage at the end of flap extension. Engagement of the stops does not occur at a time of normal operation.

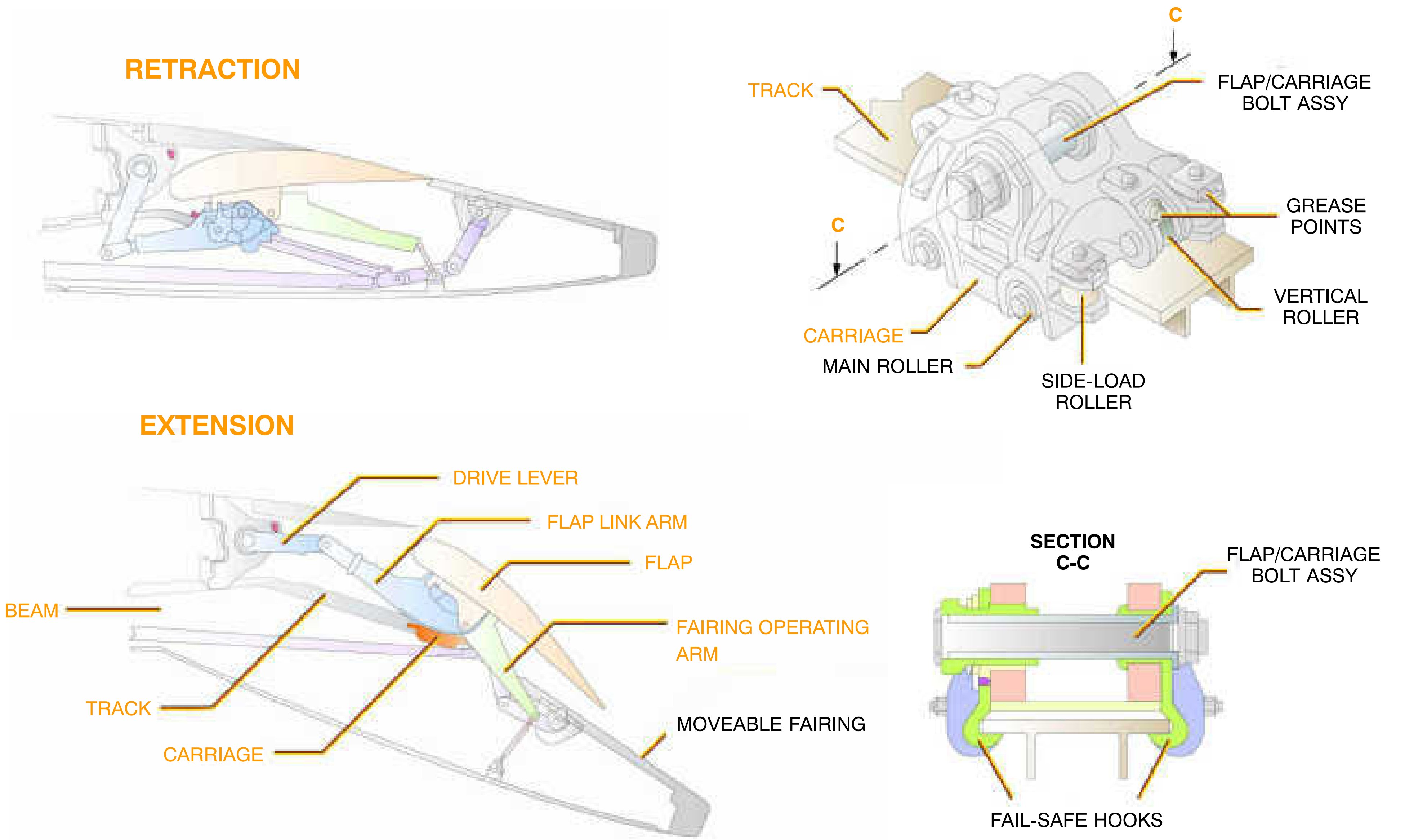


Figure 75 FLAP TRACK & CARRIAGES

Trailing Edge Flap Tabs (A321 only)

The inboard and the outboard flap each have tabs attached to their trailing edges.

Hinge mechanisms connect the trailing edge of the tab surface to the primary surface of the flap. Five hinge mechanisms hold the outboard flap tab to the outboard flap and three hinge mechanisms hold the inboard flap tab to the inboard flap.

When the flaps move, the tabs are operated by a linkage connected from:

- the shroud box assembly to the hinge 1A tab attachment bracket
- the roller carriages of the tracks 2, 3 and 4 to the tab attachment brackets.

The tabs and flaps move in relation to each other during extension and retraction.

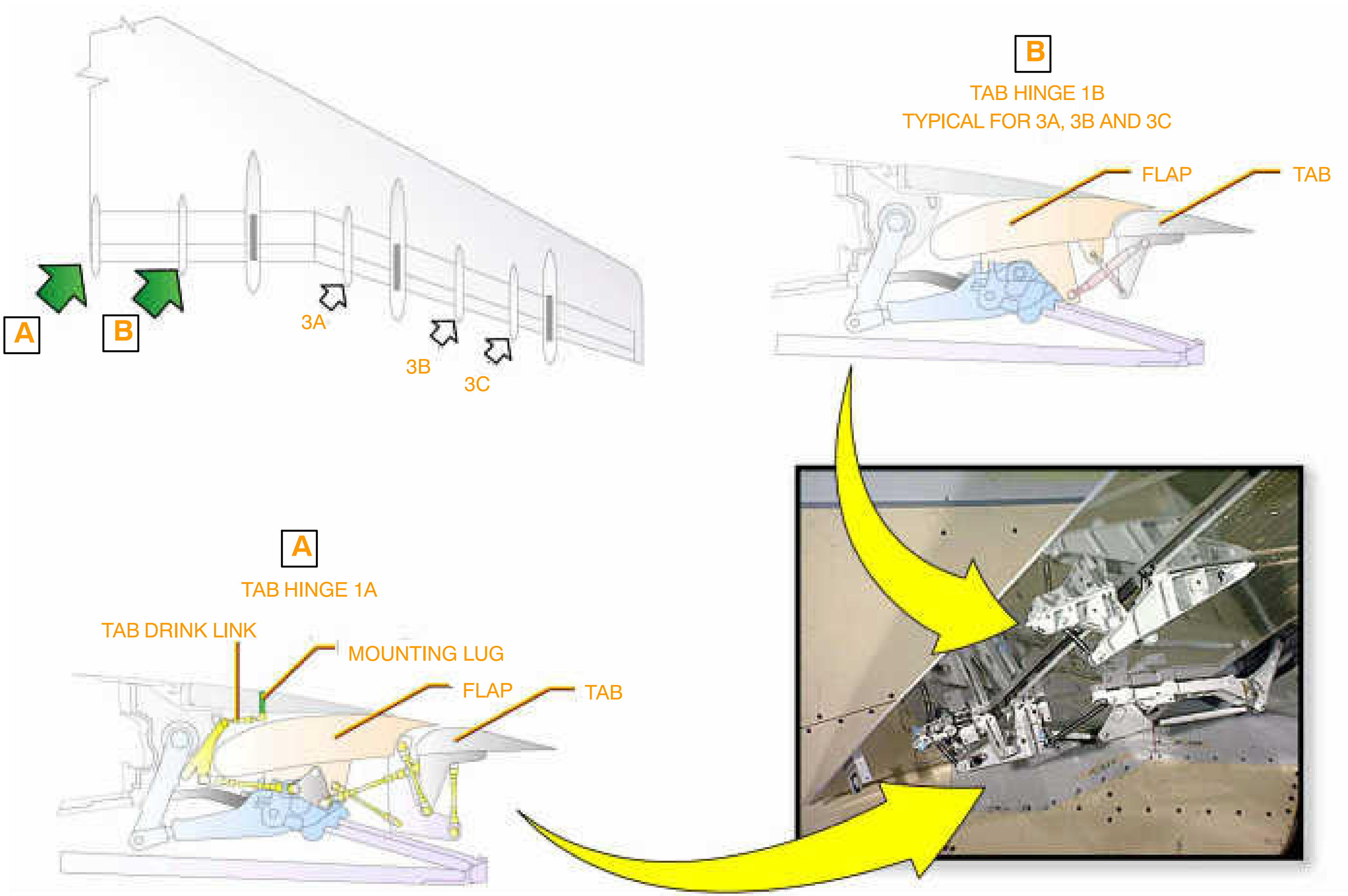


Figure 76 Trailing Edge Flap Tab (A321)

27−51/81 FLAPS/SLATS ELEC. MONITORING

FLAPS/SLATS MONITORING SYSTEM OPERATION

Flap/Slat System Monitoring

The two SFCCs monitor the systems continuously for failures in:

- the operation of the power transmission system
- the Line Replaceable Units (LRU)
- the input and output signals
- the power supplies.

Failures in the flap system will lead to warnings which are generated by the Electronic Centralized Aircraft Monitoring (ECAM) system. The ECAM system shows class 1, level 1 and level 2 cautions to the flight crew.

The SFCC's supply failure data to the ECAM system through:

- the System Data Acquisition Concentrators (SDAC)
- the Flight Warning Computers (FWC)
- the Display Management Computers (DMC)

The ECAM gives a Maintenance Status Reminder for class 2 failures.

The SFCCs supply all the related data of failures to the Centralized Fault Display System (CFDS).

The SFCC's monitor the power transmission system for these failures:

- asymmetry (a position difference between the two APPU's)
- runaway (a position difference between the APPU's 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 PPU's)
- flap disconnect
- system jam
- half speed
- low hydraulic pressure
- control valve position.

To monitor the power transmission system, the SFCCs compare the CSU signals with the position data. The SFCCs receive the position data from:

- the two APPUs
- the FPPU
- the valve blocks
- the flap−attachment failure detection sensors.

An APPU is installed at the end of the transmission system in each wing. The APPU's are the same as, and interchangeable with, the FPPU.

One synchro transmitter in each APPU sends position data to the SFCC 1. The other synchro transmitter in each APPU sends position data to the SFCC 2.

The control valve of each valve block has a Linear Variable Differential Transducer (LVDT). The LVDT sends valve position data to its related SFCC. The position of the valve is directly related to the hydraulic pressure available at the valve block.

An interconnecting strut (ICS) connects the inboard and the outboard flaps. It has two flap−attachment failure detection sensors. The flap−attachment failure detection sensors monitor the connected flaps for a position difference out of the specified limits.

Each flap−attachment failure detection sensor sends a signal to one of the two Landing Gear Control and Interface Units (LGCIU).

Each LGCIU gets a signal from one sensor on each wing and sends the data to its related SFCC. The SFCC monitors the data and sends it to the other SFCC through the cross−computer link. The SFCCs receive data from all four flap−attachment failure detection sensors.

The SFCC's monitor these LRU's for failures :

SFCC1 and 2, the CSU, the WTB's, the APPU's, the FPPU's, the valve blocks of the PCU's, the flap disconnect sensors and the hydraulic motors of the PCU's.

The SFCC's keep the data related to the failures in their memories.

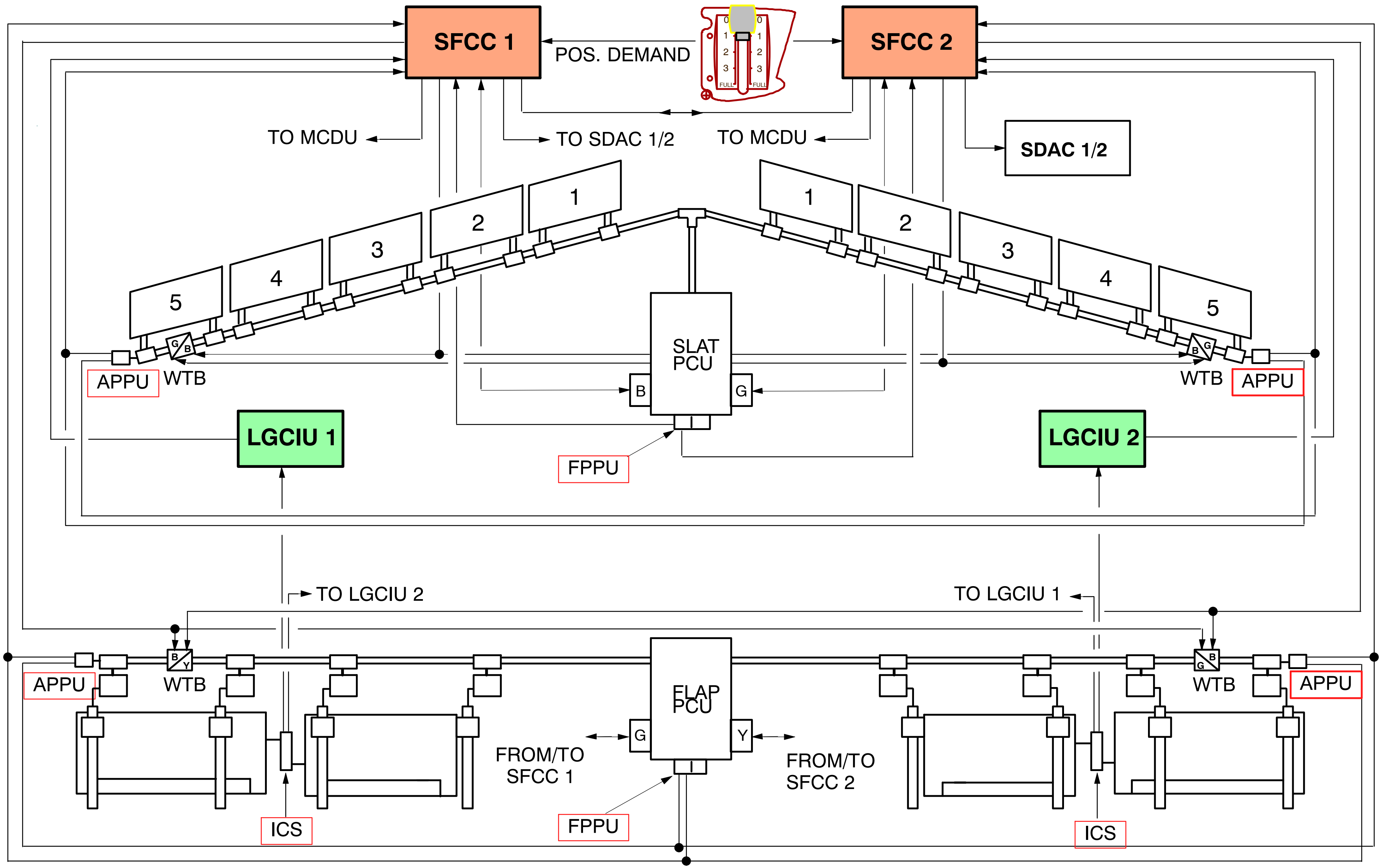


Figure 77 Transmission Monitoring Schematic

WING TIP BRAKES FUNCTIONAL OPERATION

Operation of the WTB

The WTB’s lock the transmission system if a failure occurs.

If one or the other computer finds a failure:

- the computer arms its own WTB circuits (flap or slat channel)
- the other computer receives a WTB−arm discrete signal.

If the second computer also finds the failure:

- the computer arms its own WTB circuits
- the first computer receives a WTB−arm discrete signal.

When both SFCC’s receive a WTB−arm signal they energize the related WTB solenoid valves. The WTB’s lock the transmission system.

If one SFCC does not operate, the other SFCC receives a WTB−arm signal automatically.

If the other SFCC finds a failure, one solenoid valve on each WTB gets electrical power

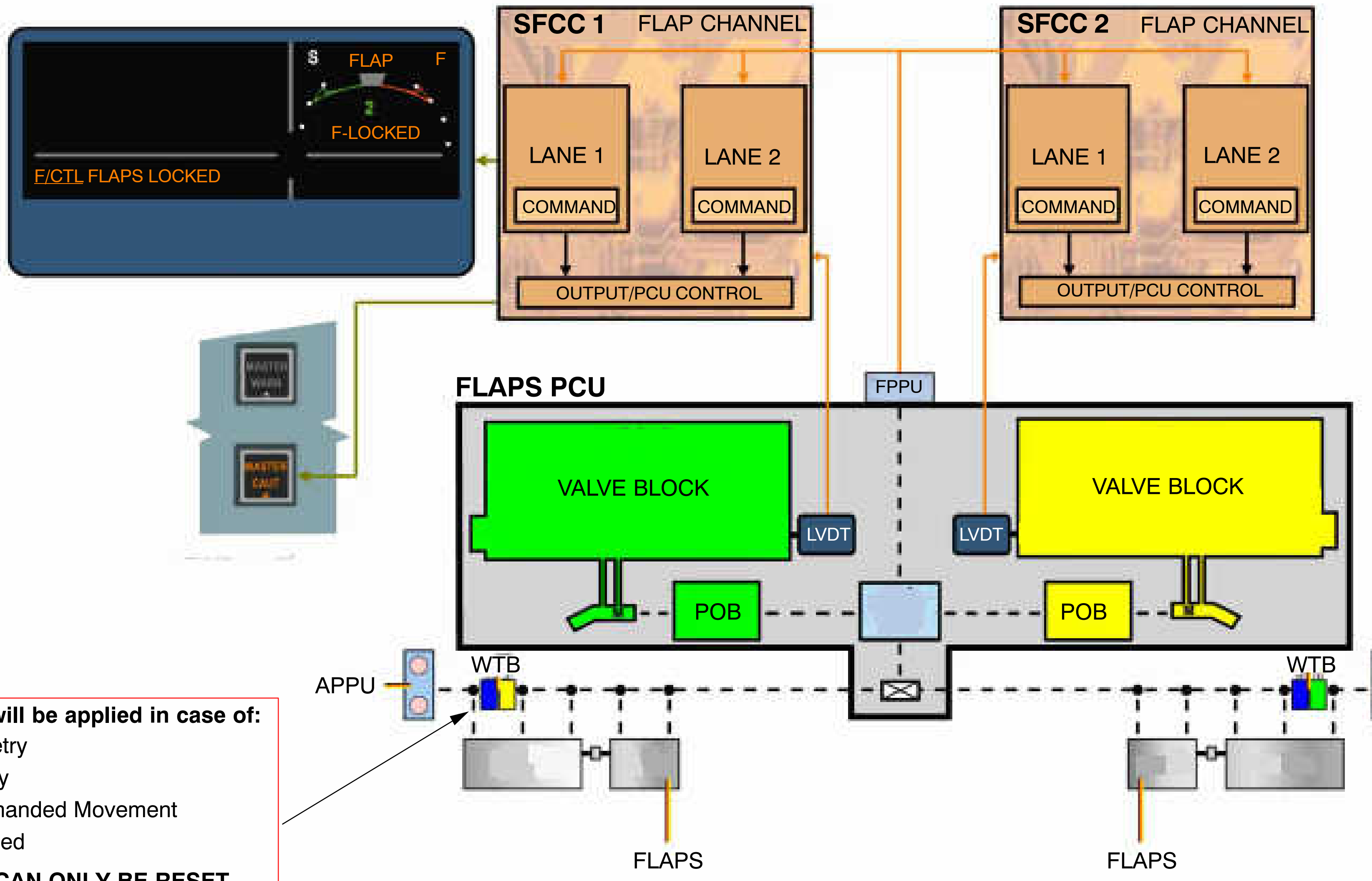
THE WTB CAN ONLY BE RESET ON GROUND THROUGH THE CFDS.

The WTB will be applied in case of:

- Asymmetry
- Runaway
- Uncommanded Movement
- Overspeed

When both SFCC’s find any one of these failures:

- the valve block solenoids on the PCU are de−energized
- the POB’s in the PCU are applied and stop their related hydraulic motors
- each computer arms its own WTB circuits and sends a WTB−arm signal to the other computer
- the WTB’s lock the transmission system
- the SFCC’s give a class 1 level 2 caution and the ECAM display unit shows a failure message.



The WTB will be applied in case of:
- Asymmetry
- Runaway
- Uncommanded Movement
- Overspeed

THE WTB CAN ONLY BE RESET ON GROUND THROUGH THE CFDS.

Figure 78 WTB Detection Circuits

WING TIP BRAKES COMPONENT DESCRIPTION

Wing Tip Brake Function

Electro−hydraulic pressure−on disk− brakes, identified as Wing Tip Brakes,are installed near the end of the transmission system on both the slats and the flaps in each wing.

The slats and the flap WTB's operate independently of each other.

The central housing contains the friction disc pack which has stator and rotor discs. The central housing holds the stator discs, external splines on the torque shaft drive the rotor discs.

The internal splines at each end of the torque shaft engage with the flap transmission system. At each end of the central housing is a hydraulic manifold which contains an annular piston. The torque shaft passes through the center of the two pistons. A solenoid valve and an electrical connector are installed on each manifold.

The solenoid valves control the supply of fluid pressure to the pistons.

The hydraulic supply to each WTB is as follows:

- the Blue and Yellow systems supply the left flap WTB
- the Blue and Green systems supply the right flap WTB.
- the Blue and Green systems supply the left and right slat WTB.

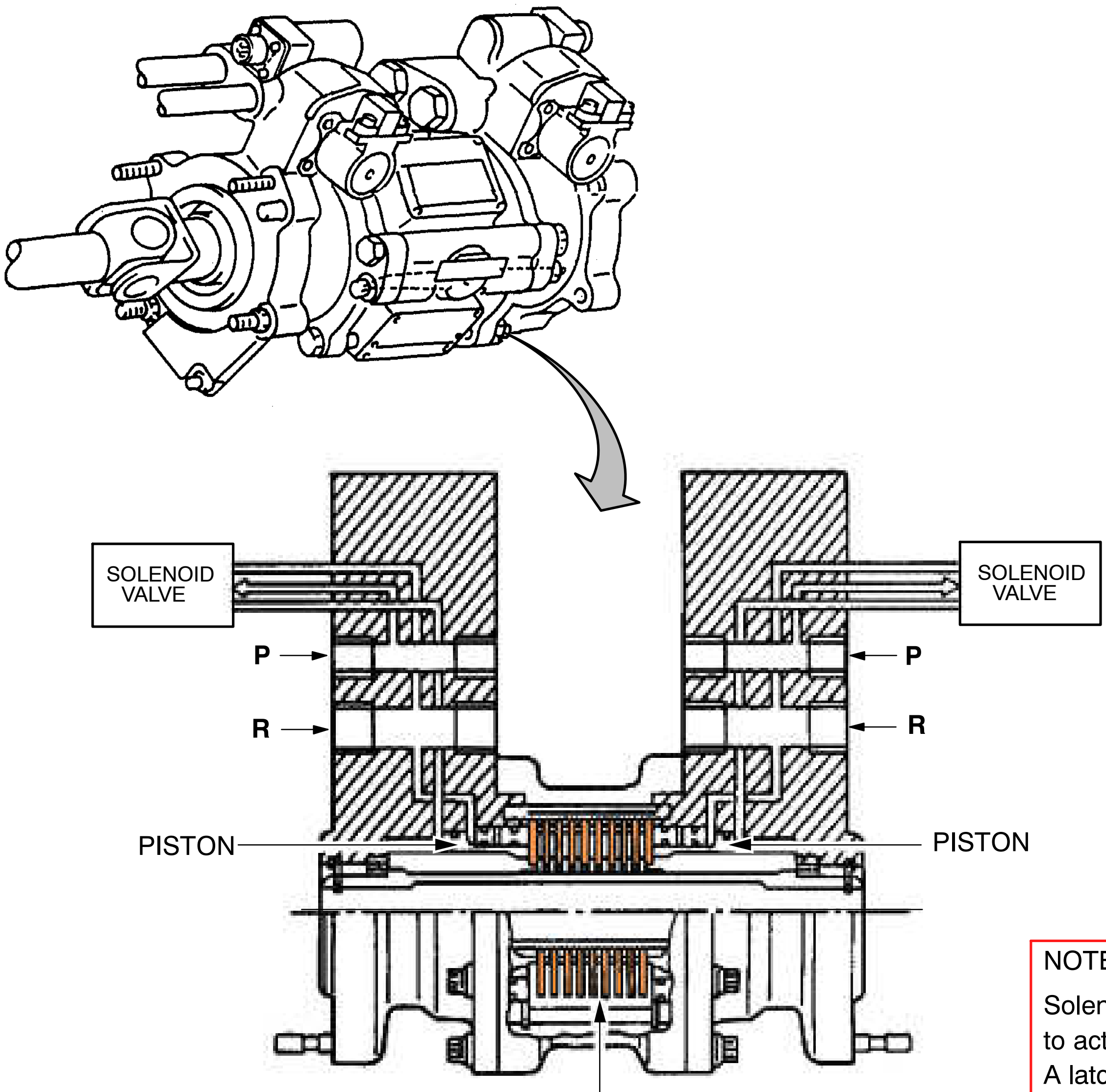
The two battery buses (701PP for system 1 and 702PP for system 2) supply power to the WTB solenoids through the SFCCs.

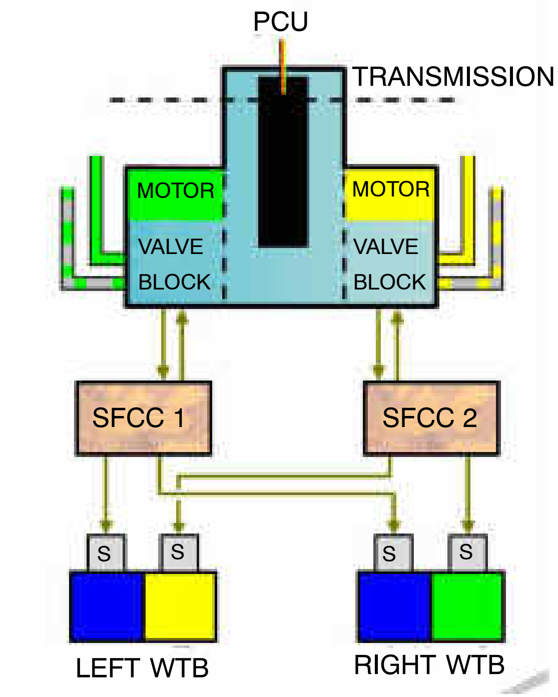
This makes sure that power is available to the WTB if there is an engine power failure. Each busbar supplies one solenoid on each WTB.

When the solenoids are energized, the fluid pressure moves the piston to release the spring force and puts the brake on. When the solenoids are de−energized, the fluid pressure returns through the solenoid valves and lets the brake off.

Leakage of fluid past the piston seals returns through a drilled hole.

If hydraulic pressure is not available to one piston, the remaining piston gives sufficient force to act against the spring to let the brake off.





NOTE:

Solenoids are energized open for hydraulic pressure
to activate the WTB.
A latching circuit keeps them energized until a reset is performed.
This reset can be performed on ground via the CFDS.

Figure 79 Wing Tip Brake

POSITION PICK OFF UNITS COMPONENT DESCRIPTION

Position Pick-off Units (PPUs)

Two PPUs are installed in the flap PCU:

- the Instrumentation PPU (IPPU)
- the Feedback PPU (FPPU)

They are the same as the Asymmetry PPU (APPU) installed in the transmission system at each wing tip. All PPUs are interchangeable.

An intermediate gear transmits the movement from the differential gearbox to the IPPU and the FPPU. Removal of the PPUs is possible without the removal of the PCU from the aircraft.

The PPU has:

- a splined input shaft
- a spring−loaded locking plate
- the reduction gears
- a reduction gear housing
- two synchro transmitters which work independently
- a synchro cover
- an electrical connector block
- a cover plate.

The spring−loaded locking plate holds the splined input shaft from the removed PPU. When the PPU is installed in the aircraft, the mount of the PPU pushes the locking plate away from the shaft splines.

The input shaft moves the reduction gears which are in the reduction gear housing. The reduction gears turn the two synchro transmitters which are below the synchro cover.

The electrical connector block is installed on the reduction gear housing. The electrical connector block has two connectors, one for each synchro transmitter. The connectors are identified as A and B.

The cover plate is installed on the reduction gear housing. There is a window in the cover plate to monitor adjustment of the PPU to zero.

When the input shaft turns through 140 revolutions it gives 360 deg. synchro transmitter output.

i.e. For full travel of the flaps (A320) , the angular output of each syncro transmitter is 231.24 deg.

To adjust the PPU electrically to zero, no electrical test equipment is necessary.

For zero adjustment, there are three moving and three fixed indicators:

- two fixed pointers on the reduction gear housing
- one zero mark on the driving gear
- one orange zero indicator
- one fixed zero mark on the input shaft locking plate
- one zero mark on the end of the input shaft.

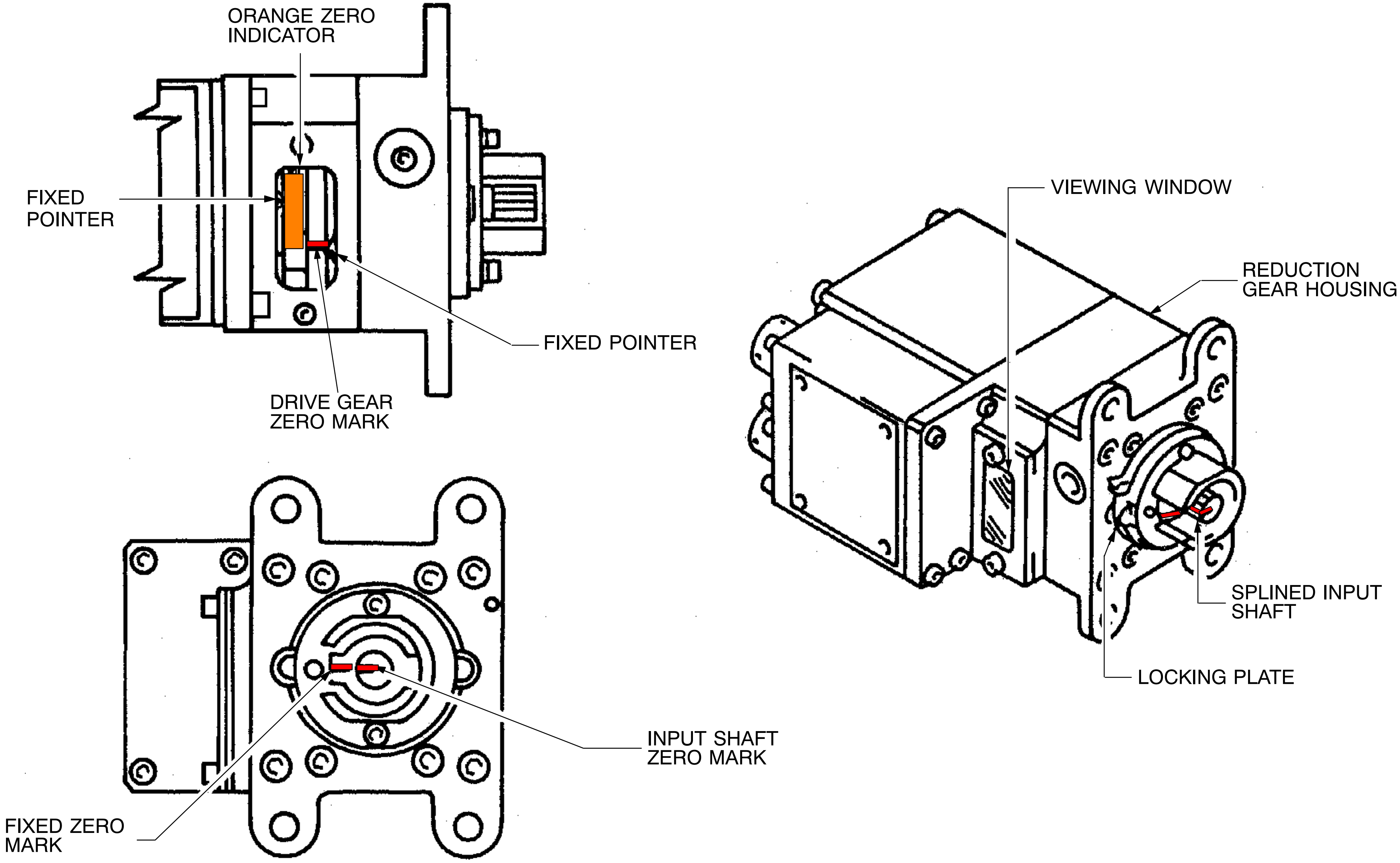


Figure 80 Position Pick-Off Units

27–51 FLAPS ELECTRICAL CONTROL AND MONITORING

FLAP ATTACHMENT MONITORING COMPONENTS DESCRIPTION

Flap Attachment Failure Detection Sensors

The SFCCs monitor the flap–attachment failure detection sensors to find connection failure. If the SFCCs receive a flap disconnect signal:

- the valve block solenoids on the PCU are de–energized
- the POBs lock the two hydraulic motors
- the SFCCs give a class 1 level 2 caution and the ECAM display unit shows a failure message.

System reset is only possible on the ground.

The ECAM display unit shows a failure message if:

- the SFCC gets different data from the two sensors on the same wing
  or
- one sensor gives incorrect data

Flap Interconnecting Strut (ICS)

The flap interconnecting strut has these functions:

- it lets the inner and the outer flaps move independently by a specified limit
- it gives a different load path for the flap drive system if there is an attachment failure
- it sends data to the SFCC when the independent movement of the inner and outer flaps is more than the specified limit
- it absorbs energy if a flap drive disconnect occurs.

The flap interconnecting strut has:

- a housing
- two flap–attachment failure detection sensors
- an actuating rod
- a target
- a ball piece
- a sleeve.

The housing contains the actuating rod, the sleeve and the ball piece. The target is at the end of the actuating rod.

The two sensors on the housing align with the targets on the actuating rod, with the flaps in their normal position.

The actuating rod has a total travel of 18 mm (0.7086 in.) in each direction from the center position. The limit of independent movement between the flaps is 14.5 mm (0.5708 in.).

The sensors send a target–far signal to the LGCIU if the target moves more than 15 mm (0.5905 in.) from the center position.

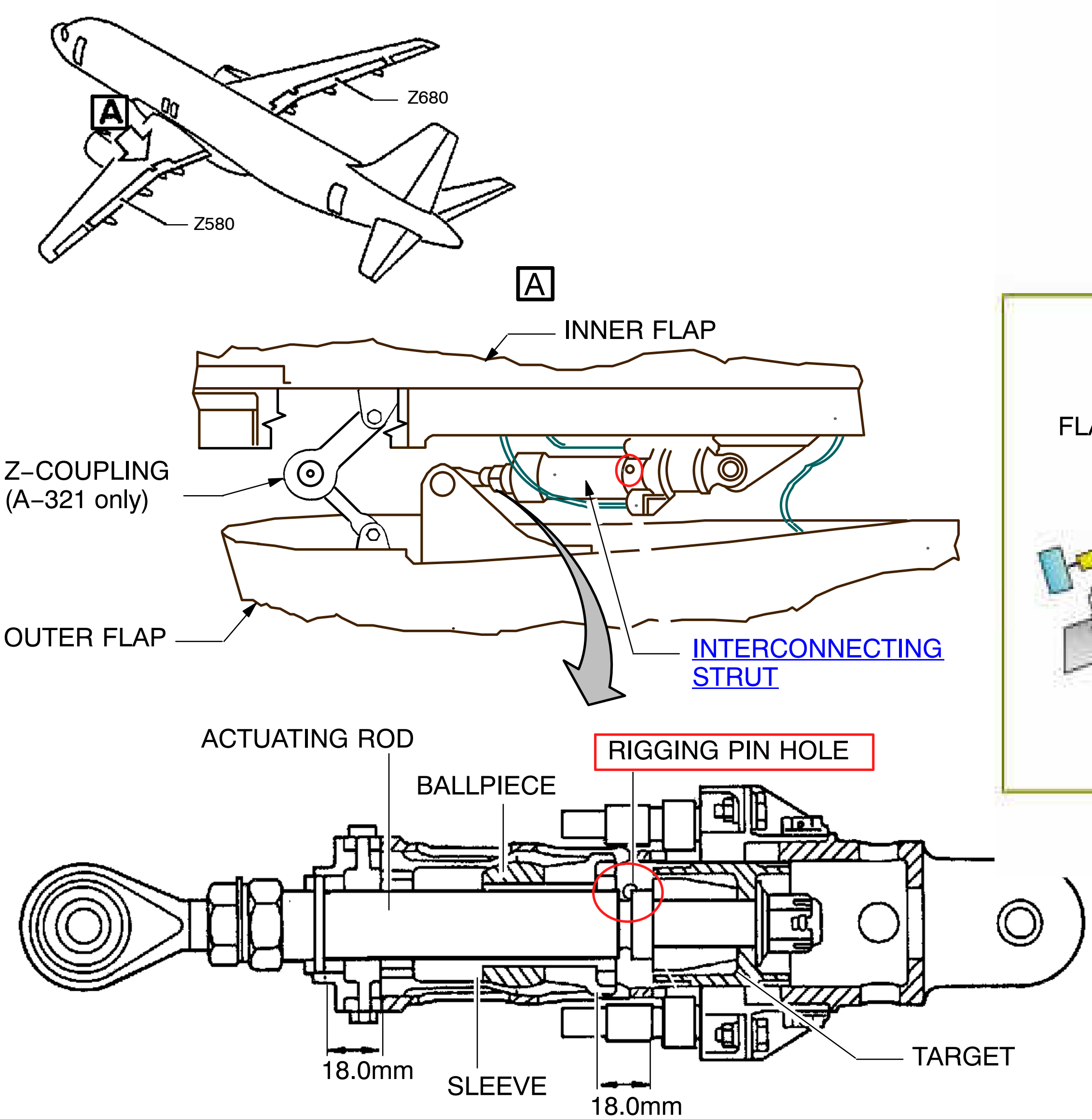
System Jam Detection

The SFCC will find a system jam if the system speed is below 2% nominal for more than 4 seconds. When the SFCC's find a system jam:

- the valve block solenoids on the PCU are de–energized
- the POBs are applied and stop their related hydraulic motors
- the SFCCs give a class 1 level 2 caution and the ECAM display unit shows a failure message.

If the SFCC's receive a new correct CSU signal, the SFCC's go back to their normal operation.

If there is low hydraulic pressure, the SFCC's stop system jam monitoring.



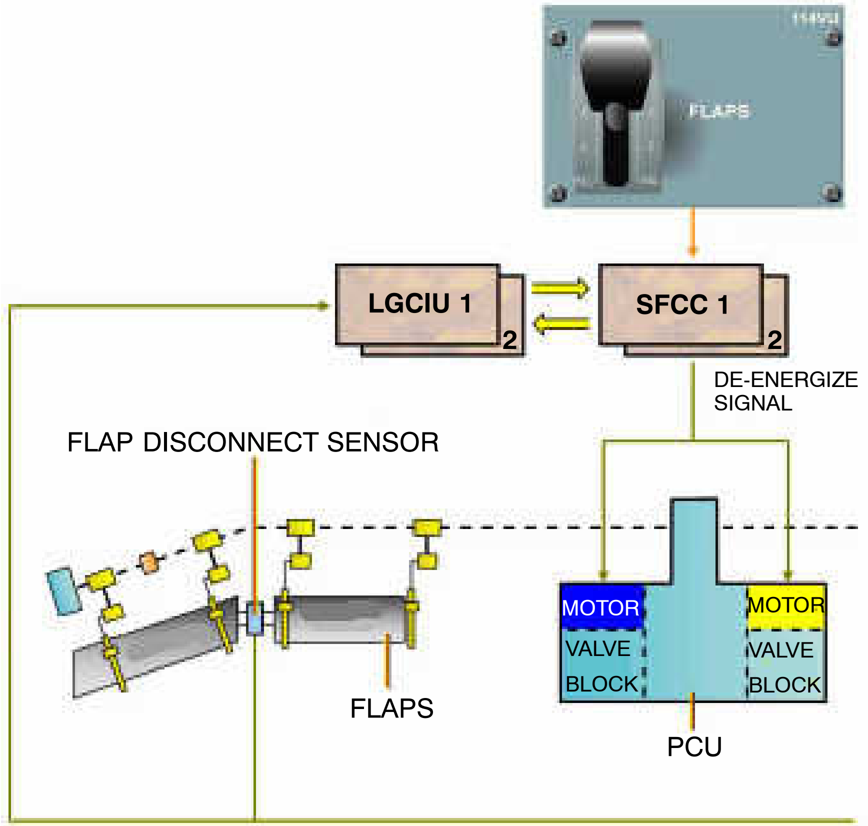


Figure 81 ICS Monitoring

27–55 FLAPS POSITION INDICATION

FLAP POSITION INDICATION FUNCTIONAL OPERATION

General

The upper display unit of the Electronic Centralized Aircraft Monitoring (ECAM) system shows the flap position. The display unit shows the flap position together with the slat position and the direction of their movement.

The Instrumentation Position Pick–Off Unit (IPPU) 3CN monitors the movement of the mechanical transmission system. It thus monitors the operation and position of the flaps.

The IPPU is attached to the flap Power Control Unit (PCU). An intermediate gear transmits the movement from the output shaft of the differential gearbox to the IPPU. The IPPU sends the flap position data to the Flight Warning Computers (FWC1, FWC2).

The FWCs send the data to the Electronic Instrument System (EIS). The EIS shows the position of the flaps on the upper display unit of the ECAM system.

The upper display unit uses the shape of a wing to show the slat and flap positions. A grey symbol shows the fixed center section of the wing. Green indications show the correct position of the slats and flaps.

When the slats and flaps are fully retracted, the green symbols are shown on the two sides of the center section of the wing.

White points show the position of the slats and flaps on the display. The white points are not shown when the slats and flaps are fully retracted (clean configuration).

The indications S and F, which are usually green, show the slat and flap part of the display. The indications are not shown when the aircraft is in the clean configuration.

The upper display unit also shows:

- the position of the slat and flap control lever
- the direction of the slat and flap surface movement
- the limit of the selected movement
- the position of the slat and flap surfaces during movement
- when the slat alpha–lock/speed baulk–function is in operation
- when the flap auto–command function is engaged.

When the slats and flaps move, the upper display unit shows:

- the FLAP indication in cyan
- the position indication of the slat/flap control lever as 0, 1 (1 + F when the flap auto–command function is engaged), 2, 3 or FULL in cyan
- the correct slat and flap position by green triangles
- the new slat and flap position by blue triangles.

When the slats and flaps reach their new position:

- the FLAP indication changes from cyan to white. The position 0 is not shown
- the position indication of the slat/flap control lever changes from cyan to green. The position 0 is not shown
- the blue triangles of the slat and flap position go out of view.

If the alpha–lock/speed baulk–function operates, the caution A–LOCK (cyan) flashes below the wing indication.

If the slats/flaps do not move freely, the FLAP indication changes from cyan to amber.

Power Supply

The 431XP ESS BUS and the 231XP Bus 2 supply 26V AC:

- 431XP ESS BUS supplies circuit breaker 1CN
- 231XP BUS 2 supplies circuit breaker 2CN
- 1CN supplies 26V AC to IPPU connector A
- 2CN supplies 26V AC to IPPU connector B.

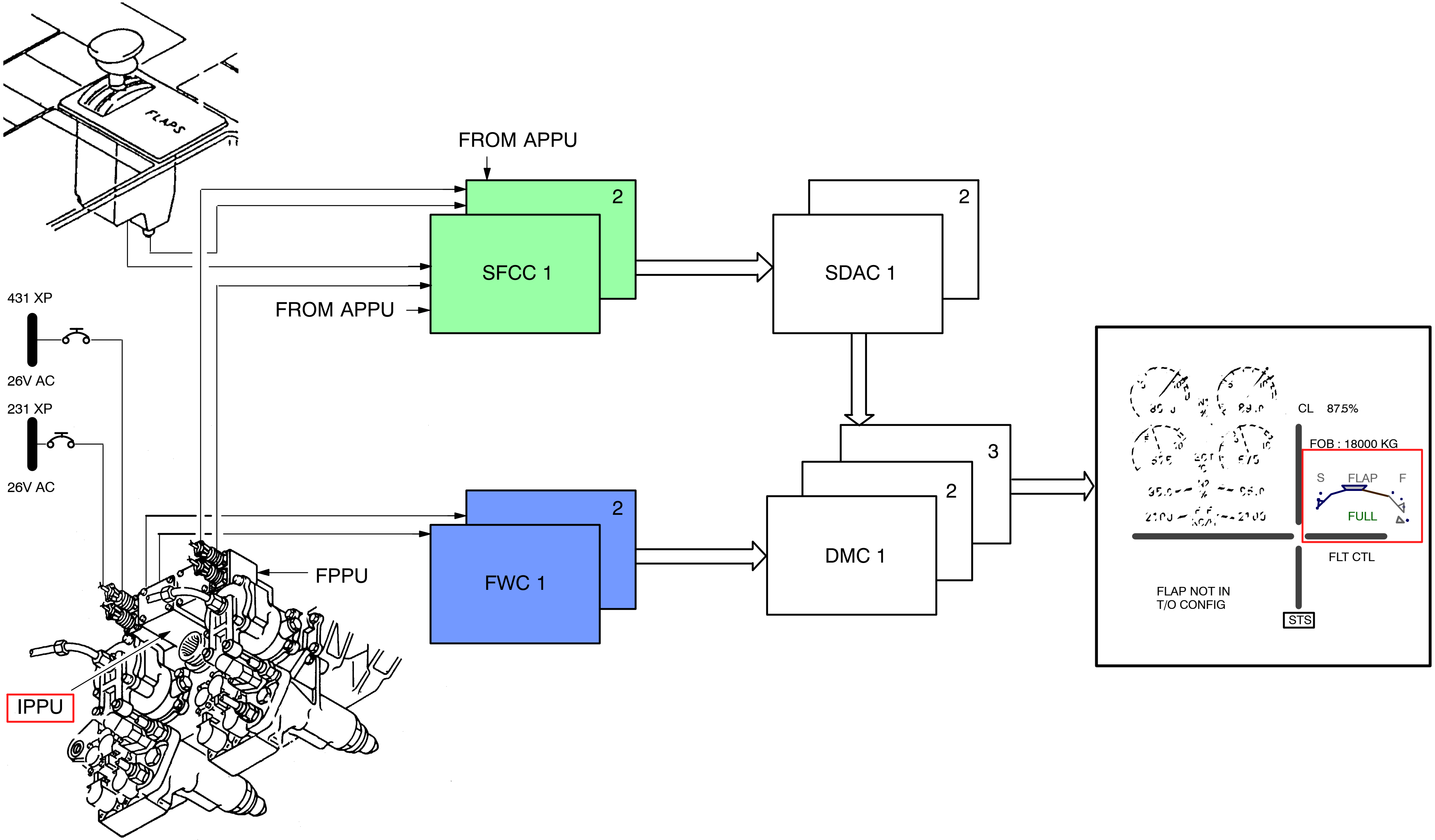


Figure 82 Flap Position Indication

27–84 SLATS POWER TRANSMISSION

SLATS MECHANICAL DRIVE PRESENTATION

General

Torque shafts and gearboxes in the fuselage and the wings transmit the mechanical power from the slat PCU to the actuators, which move the slats. Universal joints connect the torque shafts and steady bearings support them.

The slat transmission system includes:

- torque shafts in the fuselage and wings
- a 19 degree bevel gearbox which changes the direction in which the drive is aligned
- a T–gearbox which changes the direction in which the drive is aligned through 90 degrees. This gives an output to each wing
- two 63.5 degree bevel gearboxes at each wing root. These gearboxes move the drive from below wing level to the wing leading edge
- ten rotary actuators (two per slat) in each wing.

Operation

A torque shaft transmits power from the PCU to the 19 degree bevel gearbox. A second torque shaft continues the drive to the input gear of the T–gearbox. In the T–gearbox the direction in which the drive is aligned is changed through 90 degrees.

Downstream of the T–gearbox, the operation of the transmission system is the same for each wing.

Torque shafts from the T–gearbox transmit the drive to the lower of two 63.5 degree bevel gearboxes. The 63.5 degree bevel gearboxes are installed at the wing root between RIB 1 and the fuselage. A single torque shaft connects the two 63.5 degree gearboxes.

The 63.5 degree gearboxes transmit the movement from below the center wing box into the wing leading edge.

The movement is transmitted without a decrease in speed. From the upper 63.5 degree gearbox more torque shafts continue the movement through the ten rotary actuators.

When the torque shaft turns, it moves all the gearboxes and the input shafts of the rotary actuators.

The movement at the gearboxes and rotary actuators occurs at the same time and at the same speed. The rotary actuators give the necessary torque and speed decrease to move the slats at the specified rate.

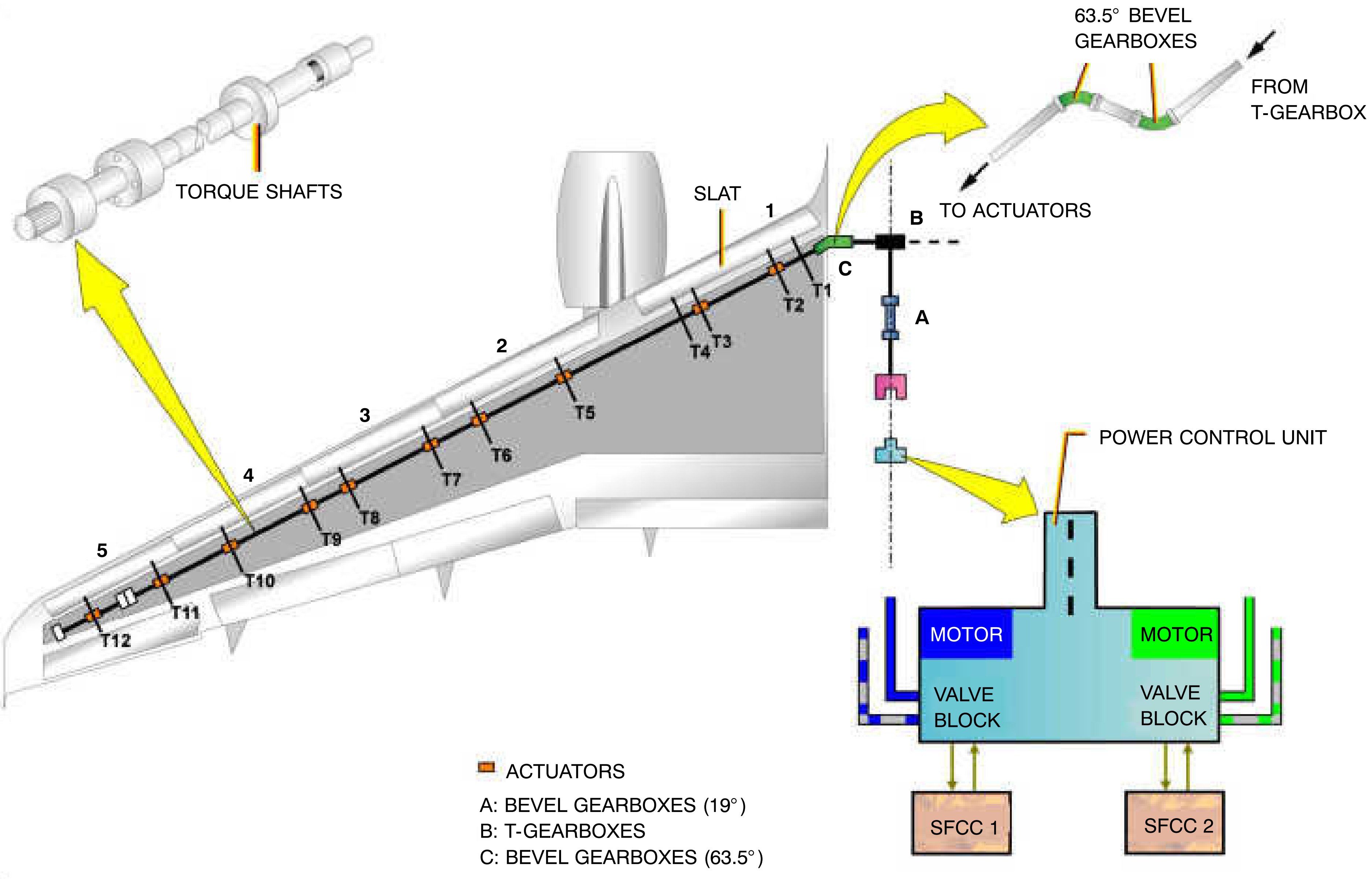


Figure 83 Slats Mechanical Drive

SLATS MECHANICAL DRIVE (CONT.)

Torque Shafts

The torque shafts are made of stainless steel. They have end fittings, which are welded.

The end fittings have a flange for a bolted joint or splines for a sliding end connection. Bolts attach universal joints and splined movable joints to the flanges where necessary.

The universal joints permit large angular changes of alignment and the splined movable joints allow small angular changes of alignment.

Each shaft has at least one sliding end connection. The external part of the sliding end connection has an indicator groove. It shows when the engagement of the external and internal parts is below a minimum.

Steady bearings, which support the torque shafts, are attached to the structure with bolts.

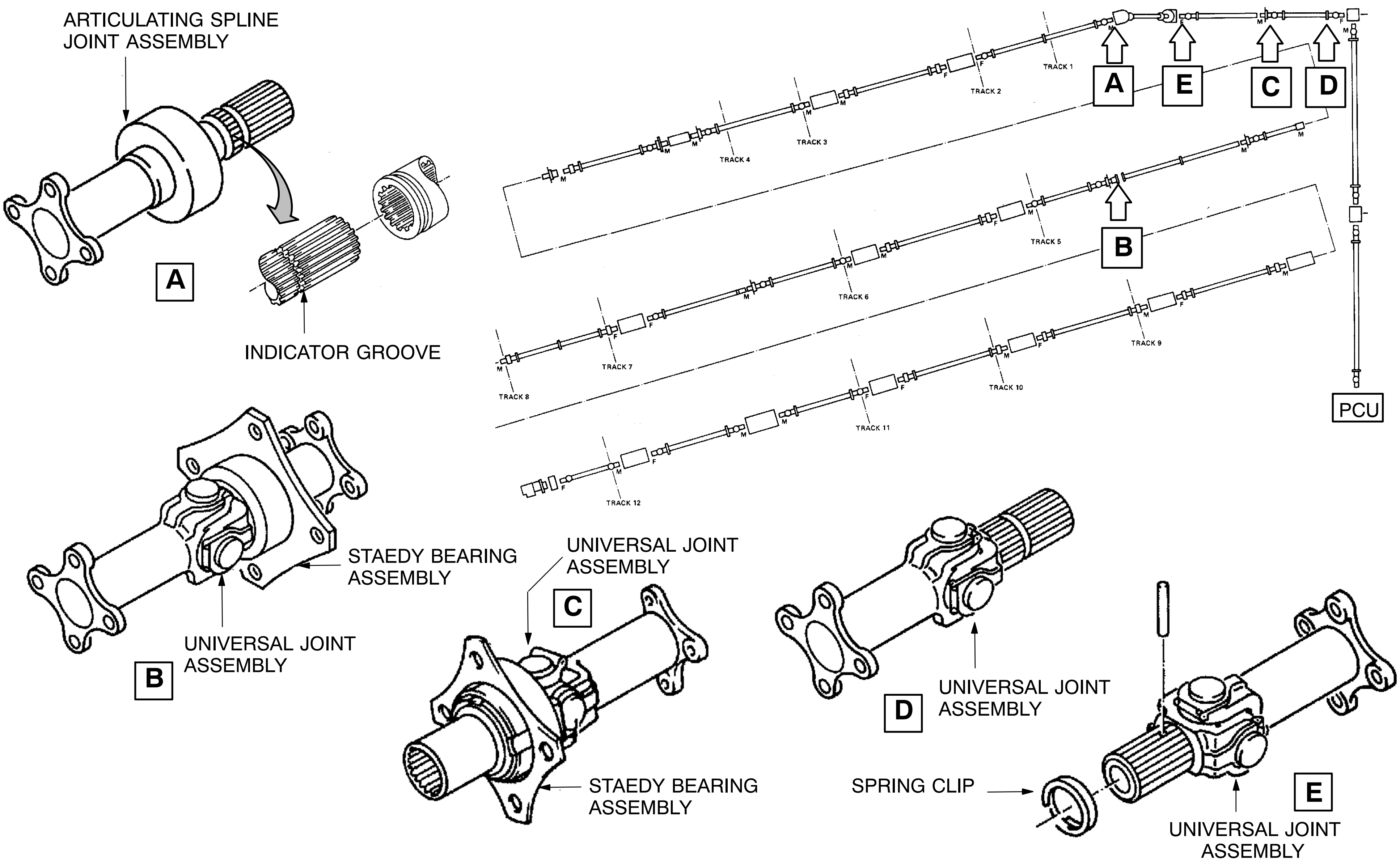


Figure 84 Slats Torque Shafts

COMPONENT DESCRIPTION

Slat PCU

The design and operation is the same as described in the Flap system 27−50.

Bevel Gearbox 19 degree

The Bevel Gearbox has a ratio of 1:1. The input and output shafts have reversed lip seals which make sure that unwanted material does not get into the gearbox. The gearbox is filled with grease. There are inspection plugs through which you can examine the lubricant.

T−Gearbox

The T−Gearbox has a ratio of 1:1. Bearings, seals and the procedures for lubrication and inspection are almost the same as those used on the 19° Bevel Gearbox.

Bevel Gearbox 63.5 degree

The four 63.5° Bevel Gearboxes have a 1:1 ratio and are the same. Bearings, seals and the procedures for lubrication and inspection are almost the same as those used on the 19° Bevel Gearbox.

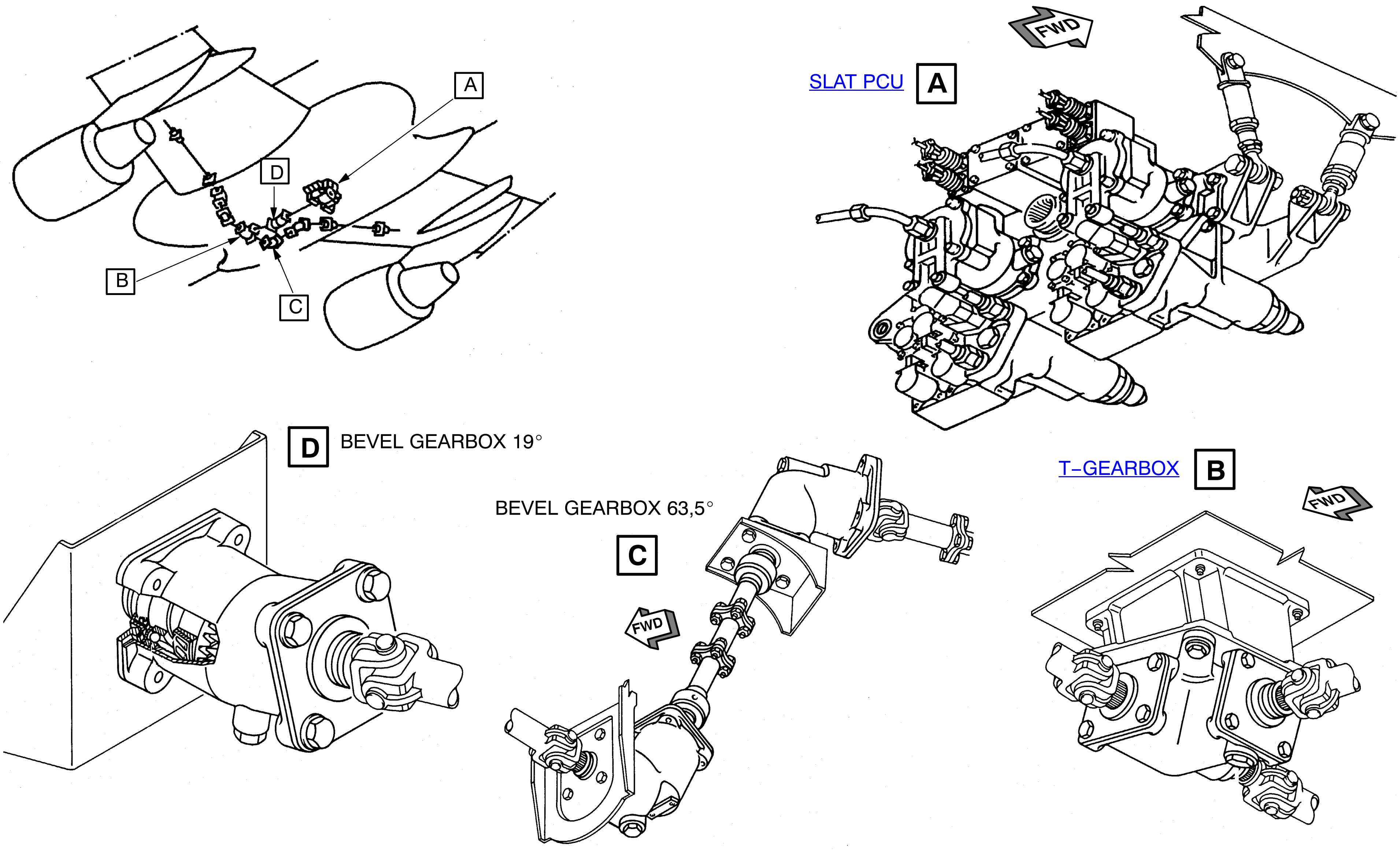


Figure 85 Slats PCU & Gearboxes

Slat Tracks

Each track runs in vertical and side load−rollers. A fixed stop is provided at each end of the driven tracks (not shown). A gear rack engages a pinion driven by the actuator output shaft.

Tracks 1 and 4 are made almost the same as the moved tracks but without the gear rack. They are to prevent that slat 1 falls away if there is a slat attachment failure.

The tracks retract through holes in the front spar into sealed containers. The sealed containers make a projection into the fuel tanks.

Actuators

There are two types of actuator in each wing. Those on tracks 2 and 3 are larger in diameter and include more gearing than the other actuators. The assembly and operation is almost the same for all actuators.

Each actuator includes:

- a cylindrical casing
- a through shaft
- a bidirectional torque limiter with latching indicator
- a sun gear
- a power output stage. (This includes a compound differential planetary arrangement of six planets, supported by rings)
- an output shaft which engages the track drive pinion.

They are pre−packed with grease for ” life time ” lubrication. Vent holes are provided in the casing for drainage of any accumulated moisture.

Attachment of the actuators is to housings. Bolts attach the housings to the structure at tracks 2, 3 and 5 thru 12.

Each actuator moves its related track through a pinion. The actuator output shaft moves the pinion which engages with a gear rack.

Torque Limiters

Each input gearbox has a torque limiter which operates in the two directions (extend/retract). Each torque limiter has a lock−out torque value set as necessary for its location.

The torque limiters protect the wing structure and the actuators from a torque overload which could occur by a slat transmission failure. A mechanical indicator on each actuator is provided to show when lock−out torque has occurred.

The mechanism may be reset by reverse operation but the indicator remains extended until cancelled manually.

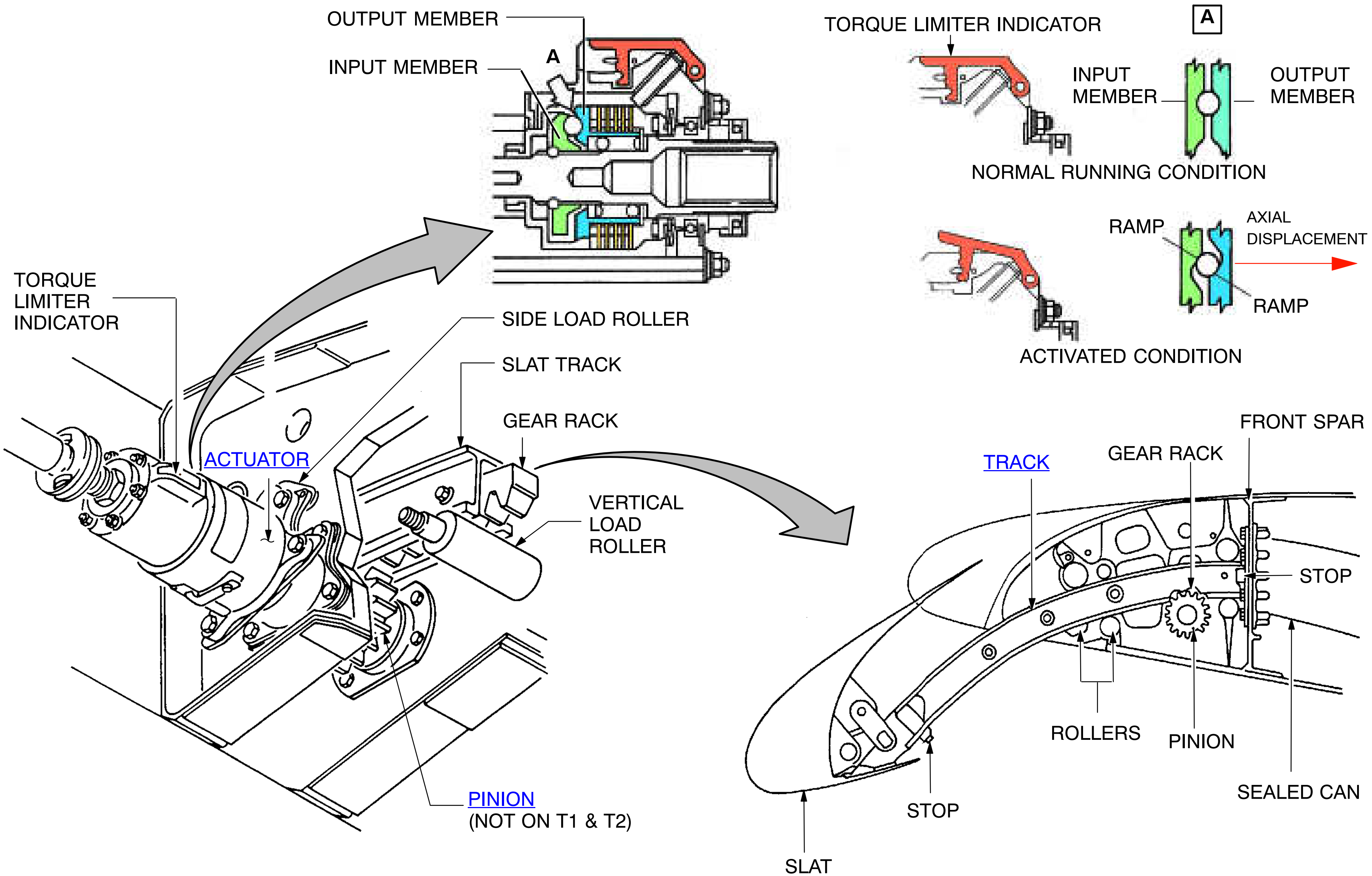


Figure 86 Slats Actuators & Track

Asymmetry Position Pick Off Unit (APPU)

The design and operation is the same as described in the Flap system 27−50.

Wing Tip Brake (WTB)

The design and operation is the same as described in the Flap system 27−50.

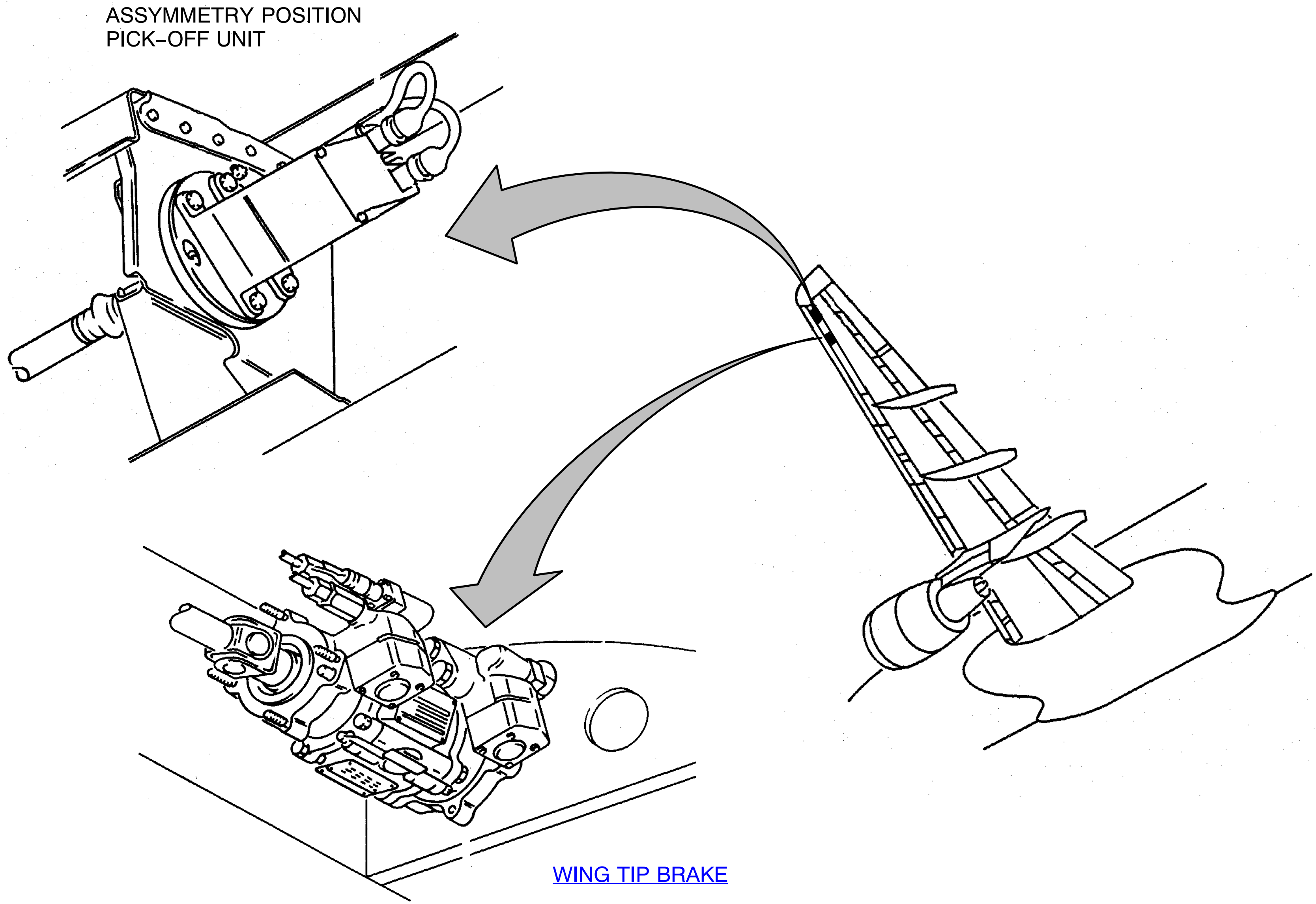


Figure 87 Slats WTB & APPU

27–81 SLATS ELECTRICAL CONTROL

SLATS POWER SUPPLY DISTRIBUTION

Slats Power Supply

The electrical power supplies for the slat control and monitoring system are:

- the essential bus 401PP
- the normal bus 202PP
- the battery buses 701PP and 702PP.

The essential bus 401PP supplies:

- the SFCC1 slat channel
- the related PCU solenoids
- the synchro and LVDT excitation voltages.

The battery bus 701PP supplies the WTB solenoids related to the SFCC1. The normal bus 202PP supplies:

- the SFCC2 slat channel
- the related PCU solenoids
- the synchro and LVDT excitation voltages.

The battery bus 702PP supplies the WTB solenoids related to the SFCC2. If the WTBs are operated, the battery buses keep the solenoids energized during a SFCC power failure.

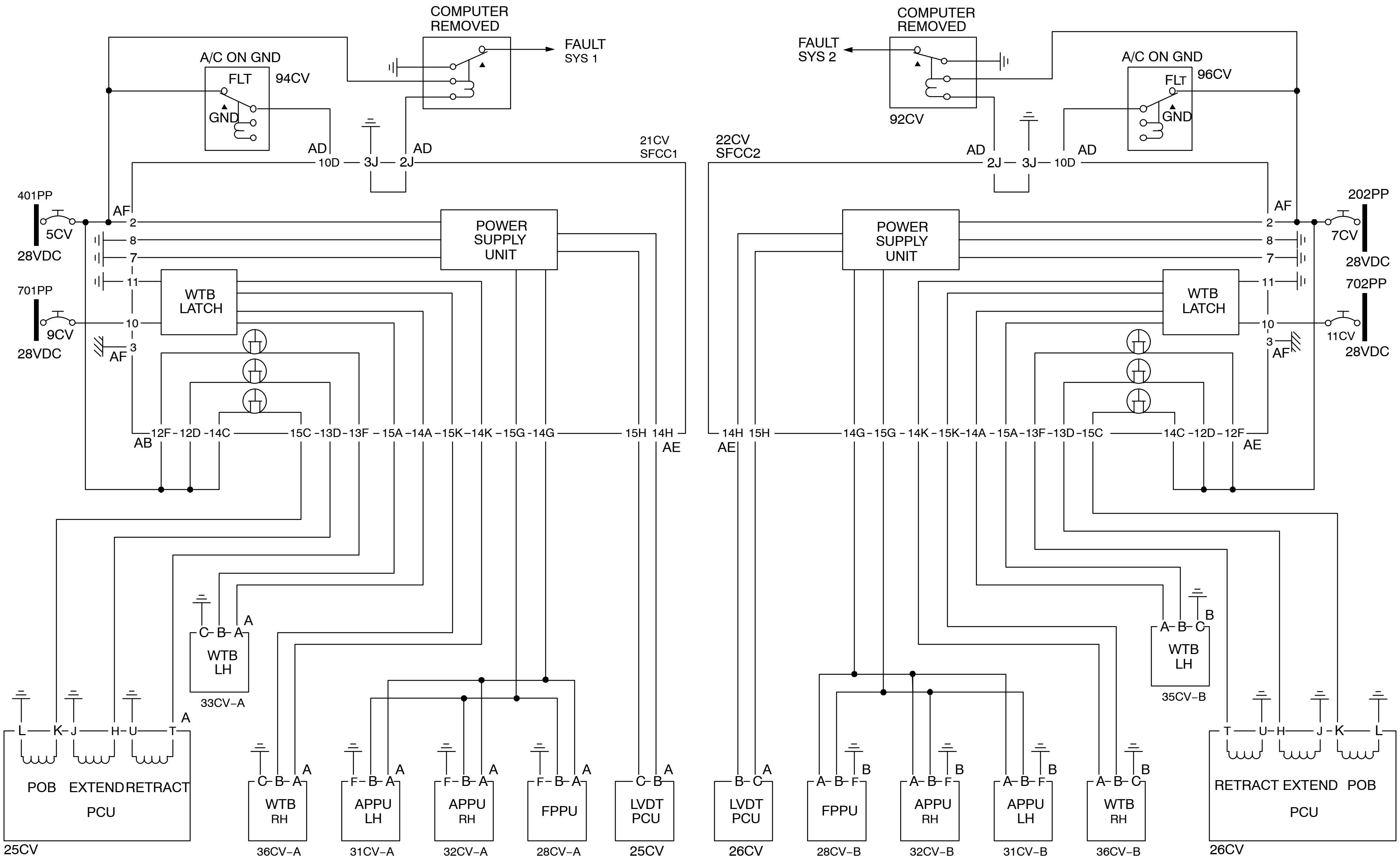
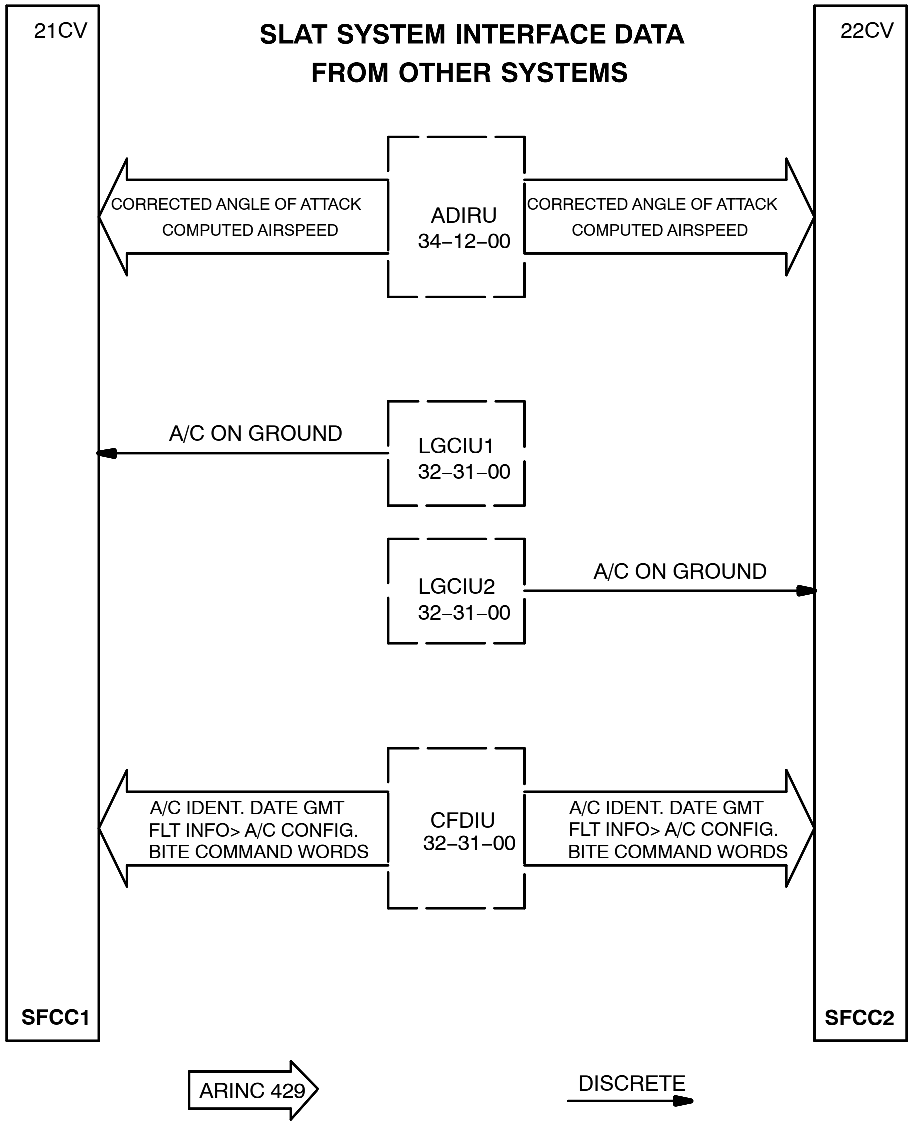


Figure 88 SFCC Slat Channel Pwr. Supply

SLAT SYSTEM COMPONENTS – INTERFACES

The SFCC's send and receive discrete and analog electrical signals to and from the components of the slat system. Each SFCC has an ARINC 429 interface,which connects it to the other systems.

The slats/flaps surface position and system health are used by a number of other aircraft systems. Surface position is mainly used as definition of configuration.



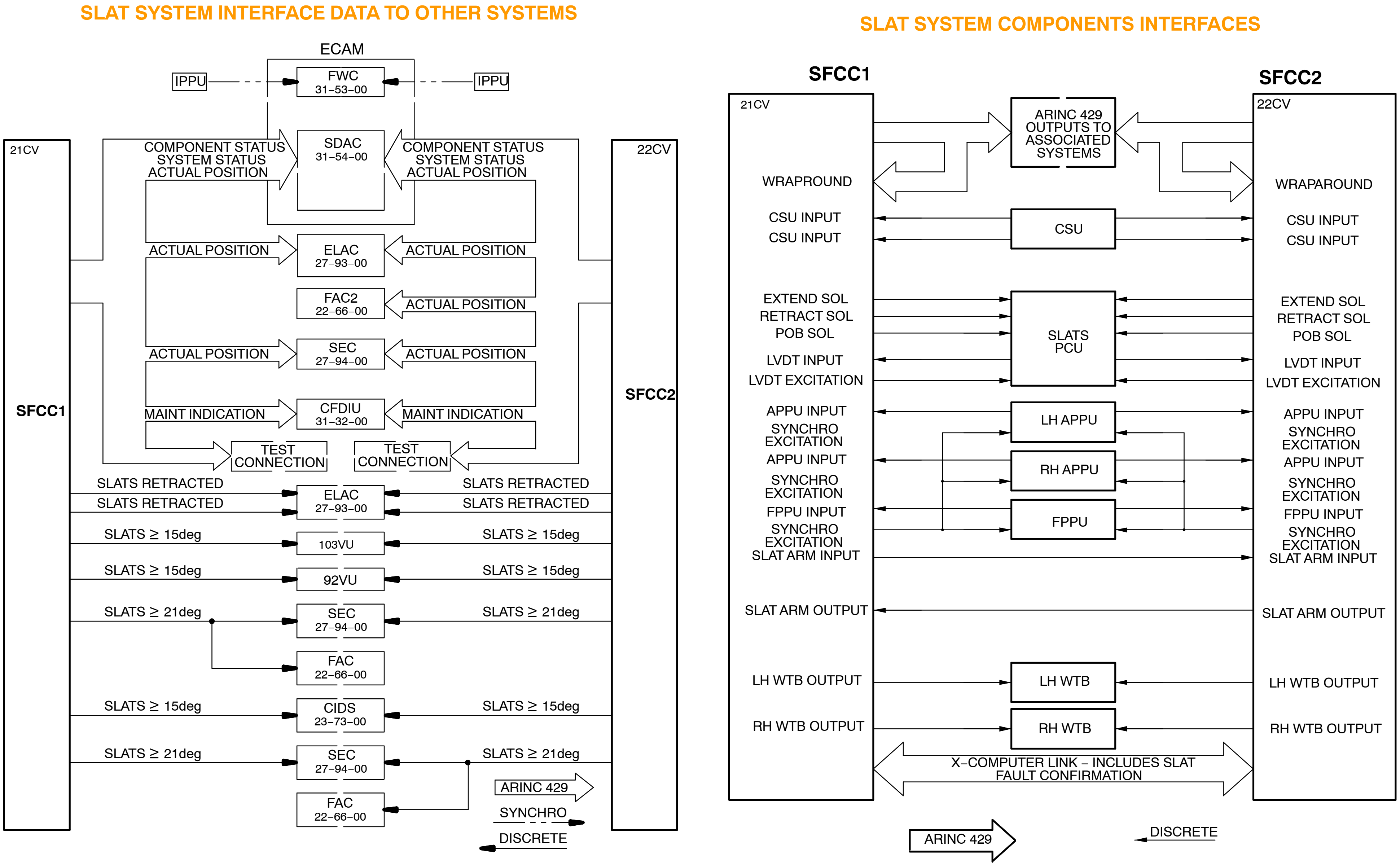


Figure 89 Slat System-Components Interfaces

27−85 SLATS POSITION INDICATION

SLATS POSITION & ALPHA LOCK/SPEED BAULK

General

The operation is the same as described as in the Flap system 27−50.

Slats Alpha Lock/Speed Baulk

The Air Data/Inertial Reference Units (ADIRU's) supply corrected angle−of−attack (alpha) and computed air speed (CAS) data to the SFCC. The SFCC use the data to prevent slat retraction at high alpha and / or low CAS. Slat retraction is not possible if:

On A319 & A320

- the alpha is more than 8.5 deg.
- the CAS is less than 148 knots.

The function resets if alpha decreases below 7.6 deg. or CAS increases over 154 knots.

On A321:

- the alpha is more than 8.0 deg.
- the CAS is less than 165 knots.

The function resets if alpha decreases below 7.1 deg. or CAS increases over 171 knots.

Alpha lock/speed baulk is not possible if:

On A319 & A320

- the slat retraction is set before alpha is more than 8.5 deg. or CAS less than 148 knots
- the aircraft is on the ground with CAS below 60 knots.

On A321 :

- the slat retraction is set before alpha is more than 8.0 deg. or CAS less than 165 knots
- the aircraft is on the ground with CAS below 60 knots.

When the function is active, the ECAM shows the message A−Lock (cyan, pulsing) below the slat position indication.

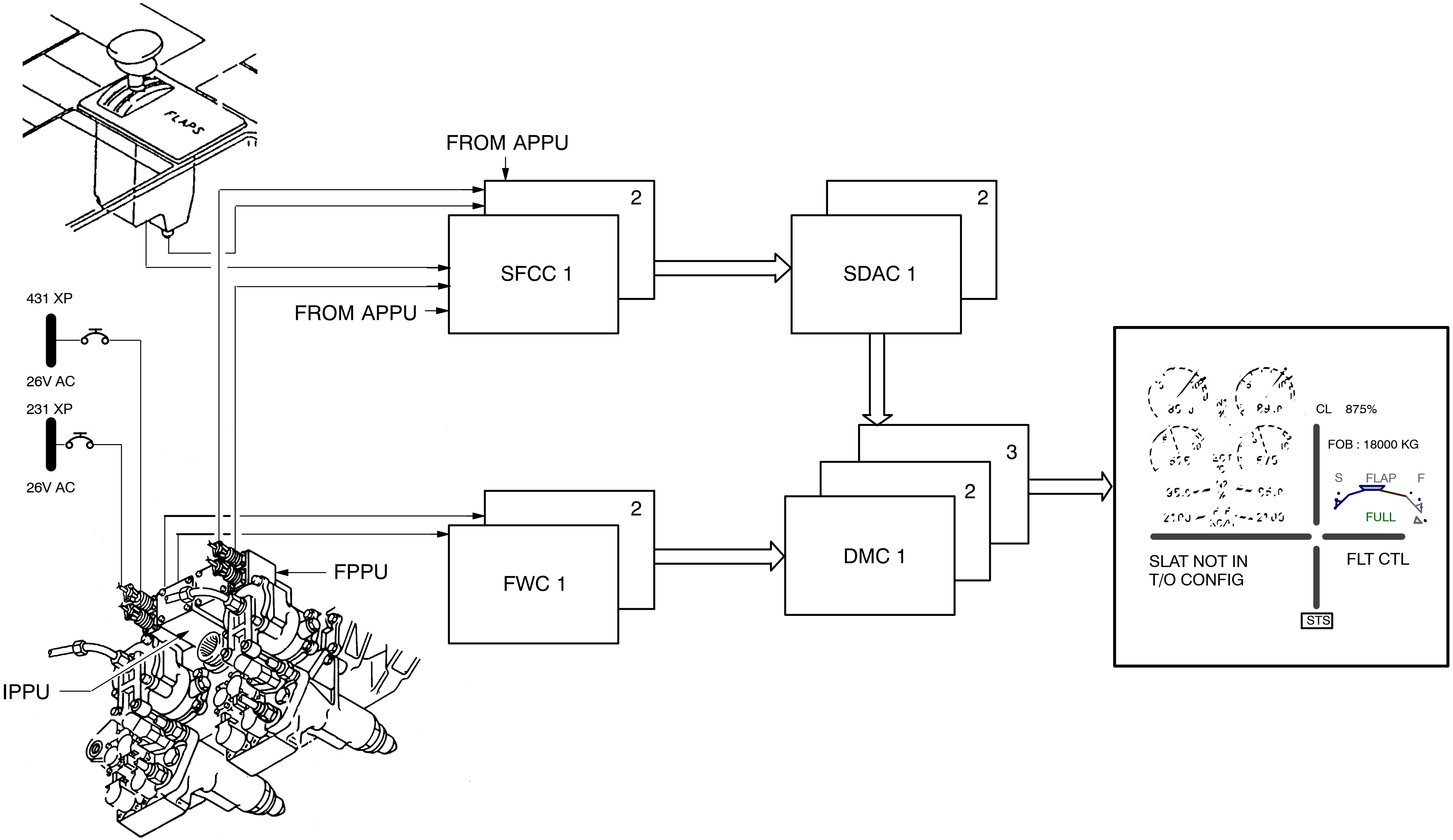


Figure 90 Slats Position Indication

27–00 FLIGHT CONTROLS GENERAL

FLIGHT CONTROLS INDICATIONS/WARNINGS (EXAMPLES)

R (L) SIDESTICK FAULT

In case of sidestick configuration warning the aural warning sounds, the MASTER WARNING and the SIDESTICK PRIORITY come on. The failure is shown red on the EWD.

SPLR FAULT

In case of a faulty pair of spoilers the aural warning sounds and the MASTER CAUTion comes on. The failure is shown amber on the EWD related to the indications on the F/CTL ECAM page.

STABILIZER JAM

In case of stabilizer jam the aural warning sounds and the MASTER CAUT comes on. The failure is shown amber on the EWD related to the indications on the F/CTL ECAM page.

L (R) AIL FAULT

In case of dual aileron servo fault the aural warning sounds and the MASTER CAUT comes on. The failure is shown amber on the EWD related to the indications on the F/CTL ECAM page.

AIL SERVO FAULT

In case of aileron servo fault, the failure is shown amber on the EWD related to the indications on the F/CTL ECAM page.

ALTN LAW

In case of F/CTL normal law failure the aural warning sounds and the MASTER CAUT comes on. The F/CTL ECAM page is not called.

ELAC FAULT

In case of Flight Control Computer (FCC) failure the aural warning sounds, the MASTER CAUT and the ELAC 1 FAULT lights come on. The failure is shown amber on the EWD related to the indications on the F/CTL ECAM page.

ELAC PITCH FAULT

In case of ELAC pitch fault the ECAM is activated. The failure is shown amber on the EWD. The ELAC symbol remains green.

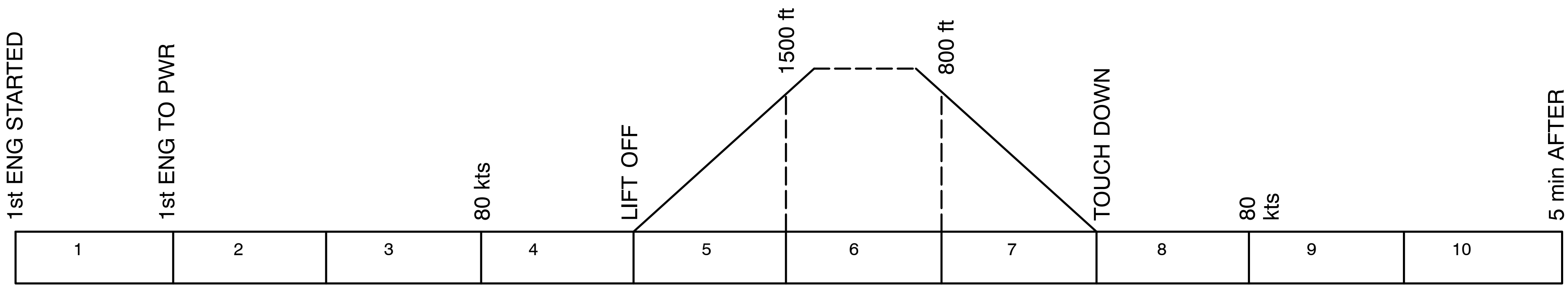


Figure 91 Flight Controls - ECAM Warning Profile

WARNINGS AND CAUTIONS

<table>
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CONDITIONS</th><th>AURAL
WARNING</th><th>MASTER
LIGHT</th><th>SD
PAGE
(AUTO)</th><th>LOCAL
WARNING</th><th>FLT
PHASE
INHIB</th></tr>
<tr><td>CONFIG
• SPD BRK NOT RETRACTED or
• PITCH TRIM NOT IN T.O. RANGE
A/C not in T.O. configuration when thrust levers are set at T.O. or FLEX T.O. or when pressing T.O. CONFIG PB</td><td rowspan="3">CRC</td><td rowspan="3">MASTER WARN</td><td rowspan="5">F/CTL</td><td>NIL</td><td>5, 6, 7, 8</td></tr>
<tr><td>CONFIG R (L) SIDESTICK FAULT
(BY TAKE OVER)
L or R sidestick is inoperative (take over P/BSW pressed more than 30 sec.) when thrust levers are set at T.O. or FLEX T.O., or when pressing T.O. CONFIG PB</td><td>Red*
SIDESTICK
PRIORITY Lt</td><td>5, 6, 7, 8</td></tr>
<tr><td>L + R ELEV FAULT
Loss of both elevators</td><td>PFD
Message</td><td></td></tr>
<tr><td rowspan="2">L (R) SIDESTICK FAULT
Transducers on pitch or roll axis are failed on one sidestick.</td><td rowspan="2">SINGLE CHIME</td><td rowspan="2">MASTER CAUT</td><td>NIL</td><td>4, 5, 7, 8</td></tr>
<tr><td>FAULT Lt on ELAC
PB</td><td rowspan="3">4, 5, 7, 8</td></tr>
<tr><td>ELAC 1 FAULT
Failure of ELAC (pitch and roll channel) or one side stick transducer fault.</td><td rowspan="6">SINGLE CHIME</td><td rowspan="6">MASTER CAUT</td><td>F/CTL</td><td>NIL</td></tr>
<tr><td>SEC 1 (2) (3) FAULT
Failure of on SEC</td><td rowspan="3">F/CTL</td><td>FAULT Lt on
SEC PB</td></tr>
<tr><td>FCDC 1 + 2 FAULT
Failure of both FCDCs</td><td>NIL</td><td>4, 5, 7</td></tr>
<tr><td>DIRECT LAW
Direct laws are active</td><td>PFD
Message</td><td rowspan="2">4, 5, 7, 8</td></tr>
<tr><td>ALTN LAW
Alternate laws are active</td><td rowspan="2">NIL</td><td>NIL</td></tr>
<tr><td>IR DISAGREE
Disagree between two IR, with the third one failed</td><td>FAULT Lts on
ELAC PBs and
PFD Message</td><td>3, 4, 5, 7</td></tr>
</table>

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<table>
<tr><th>EWD: FAILURE TITLE
CONDITIONS</th><th>AURAL
WARNING</th><th>MASTER
LIGHT</th><th>SD
PAGE
(AUTO)</th><th>LOCAL
WARNING</th><th>FLT
PHASE
INHIB</th></tr>
<tr><td>CONFIG SLATS (FLAPS) NOT IN T.O. CONFIG
Slats or flaps are not in T.O. configuration when thrust levers are set at T.O. of FLEX T.O. or when depressing T.O. CONFIG P/BSW.</td><td>CRC</td><td>MASTER WARN</td><td rowspan="7">NIL</td><td rowspan="7">NIL</td><td>5,6,7,8</td></tr>
<tr><td>SLATS (FLAPS) FAULT
Failure of both slat or flap channels.</td><td rowspan="2">SINGLE CHIME</td><td rowspan="2">MASTER CAUT</td><td rowspan="2">4, 5, 8</td></tr>
<tr><td>SLATS (FLAPS) LOCKED
Slats or flaps wing tip brakes applied or non alignment detected between 2 flaps.</td></tr>
<tr><td>SLATS SYS 1 (2) FAULT
Failure of slat channel in one SFCC.</td><td rowspan="4">NIL</td><td rowspan="4">NIL</td><td rowspan="4">3, 4, 5, 7, 8</td></tr>
<tr><td>FLAP SYS 1 (2) FAULT
Failure of flap channel in one SFCC.</td></tr>
<tr><td>FLAPS ATTACH SENSOR
Failure of flap attachment failure detection sensor.</td></tr>
<tr><td>SLAT (FLAP) TIP BRK FAULT
Failure of one wing tip brake on slats or flaps or failure of one wing tip brake solenoid on slats or flaps.</td></tr>
<tr><td>R (L) SIDESTICK FAULT</td><td>CRC</td><td>MASTER WARN</td><td rowspan="5">F/CTL</td><td>PRIORITY
LT</td><td>4,5,6,7,8</td></tr>
<tr><td>SPLR FAULT</td><td rowspan="3">SINGLE CHIME</td><td rowspan="3">MASTER CAUT</td><td rowspan="5">NIL</td><td>3,4,5,7</td></tr>
<tr><td>STABILIZER JAM</td><td>4,5</td></tr>
<tr><td>L (R) AIL FAULT</td><td>3,4,5,7</td></tr>
<tr><td>AIL SERVO FAULT</td><td>NIL</td><td>NIL</td><td>3,4,5,7</td></tr>
<tr><td>ALTN LAW</td><td>SINGLE CHIME</td><td>MASTER CAUT</td><td>NIL</td><td>4,5,7,8</td></tr>
</table>

27−50/80 FLAPS/SLATS

SFCC BITE TESTS

General

The flap system has a **B**uilt−**I**n **T**est **E**quipment (BITE). You can do tests of the system through the Multipurpose Control and Display Unit (MCDU) in the aircraft cockpit.

The MCDU also indicates any failures in the system and gives trouble shooting data for the system.

The two SFCC's also do a BITE check during power−up.

Maintenance access for trouble shooting and SFCC tests is performed via the CFDS menu. The access to the SFCC is via the F/CTL obtained by selecting "SYSTEM REPORT/TEST". (Some examples are given below)

The CFDS will give advice and will also display the test result. For certain tests, the surface will operate.

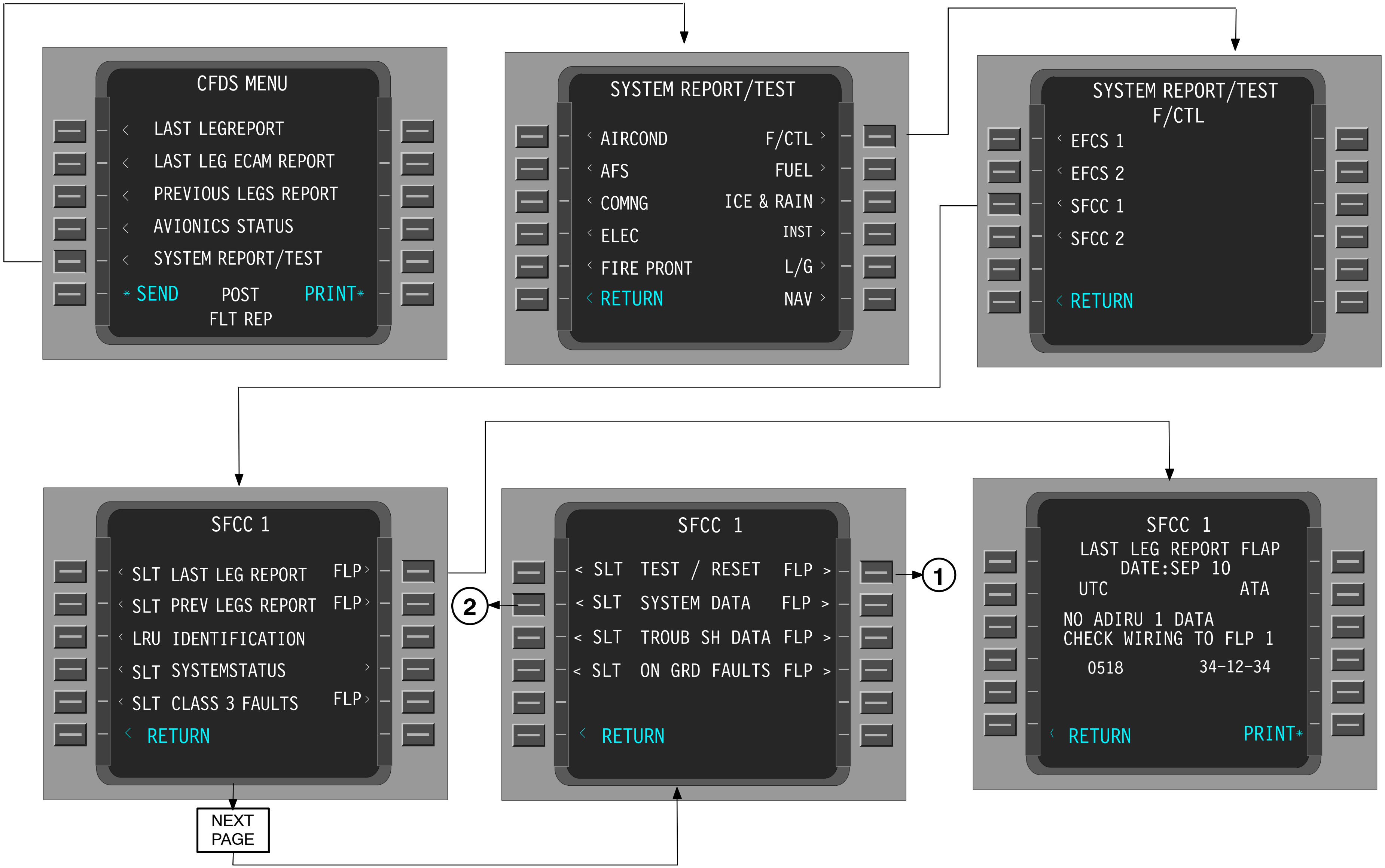

Figure 92 MCDU Data Utilization

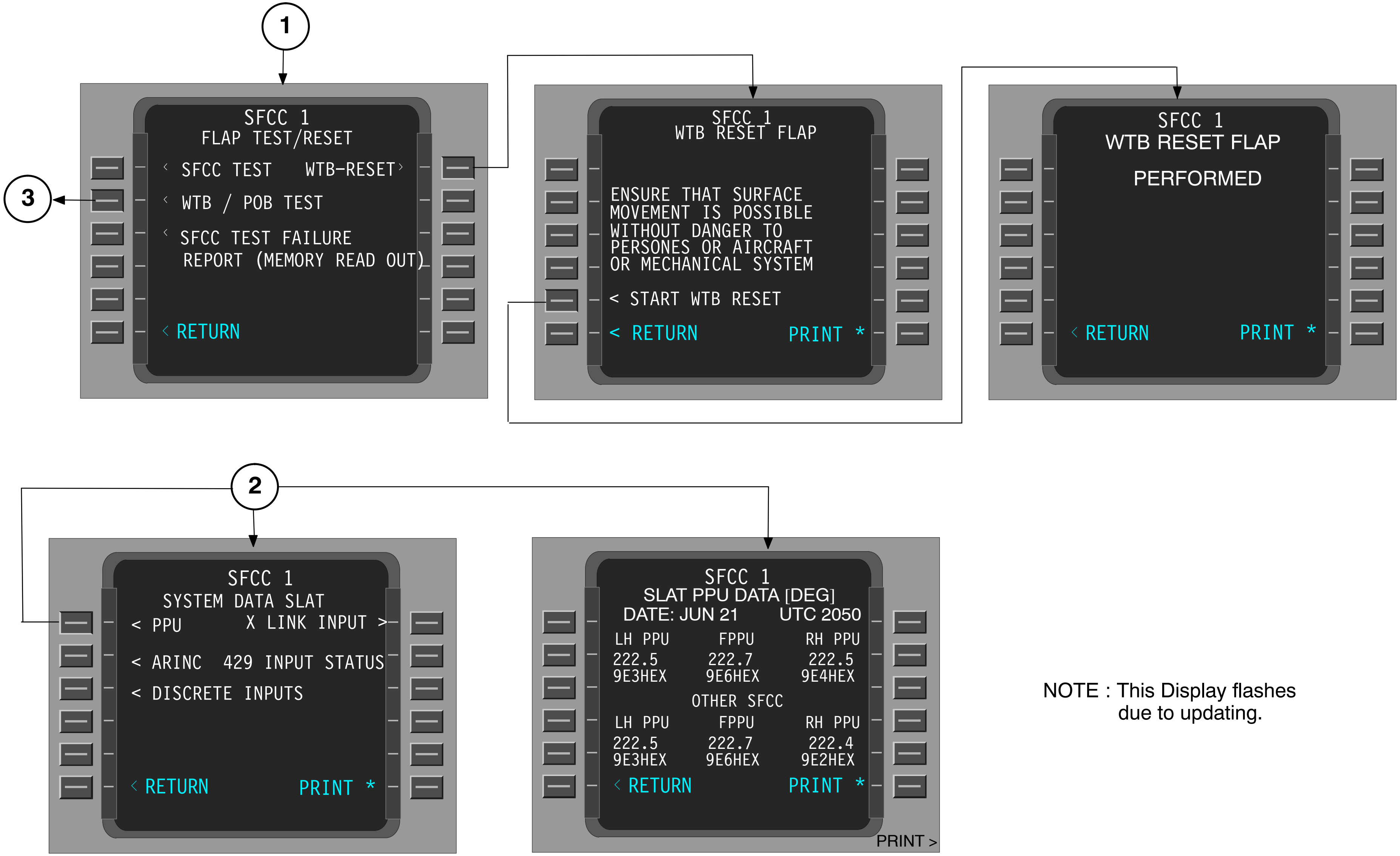

Figure 93 WTB Reset & PPU Datas

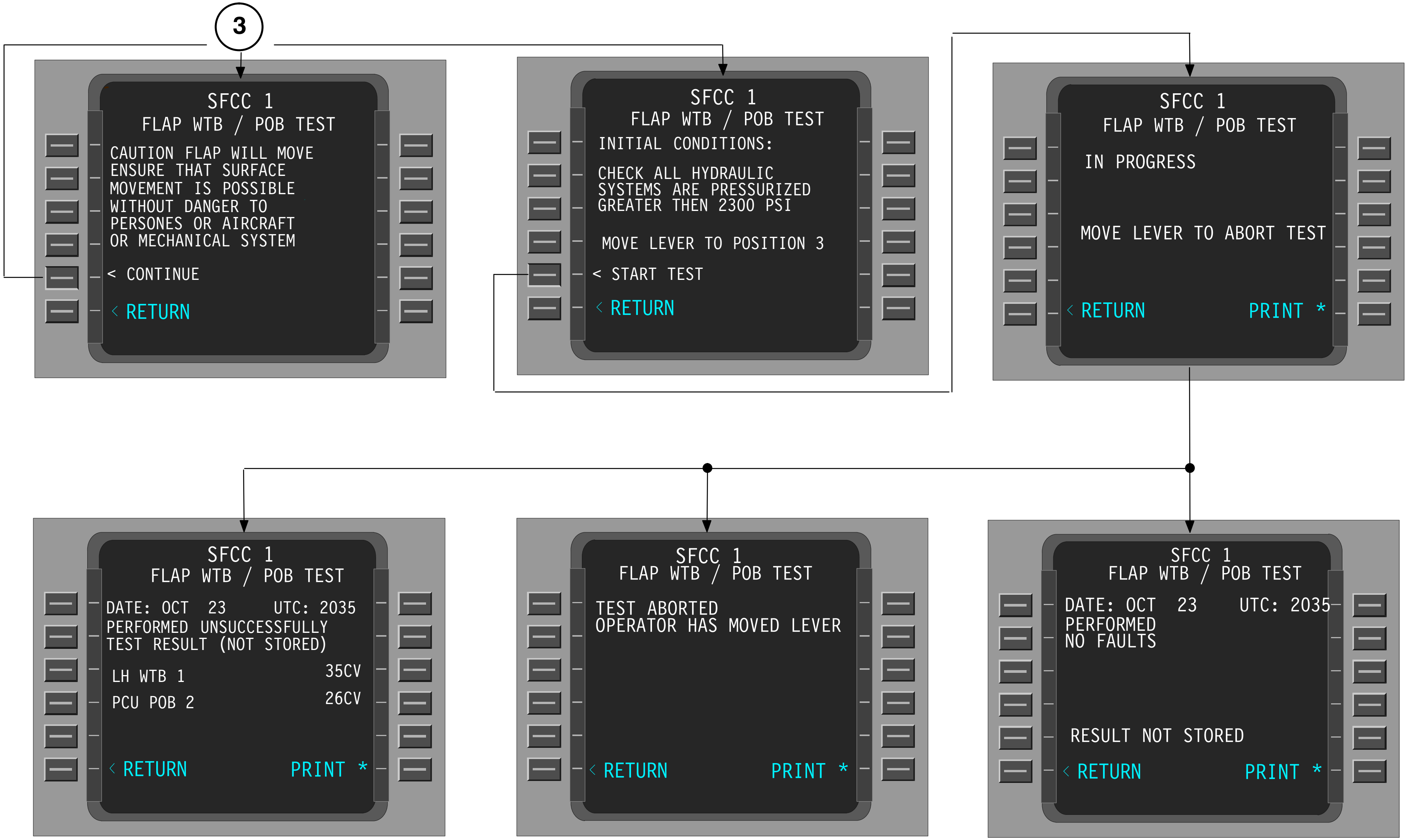

Figure 94 WTB/POB Test

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