A330-200
TECHNICAL TRAINING MANUAL

MECHANICS / ELECTRICS & AVIONICS COURSE

27 FLIGHT CONTROLS

GE Metric

Issued By SPL/GK March 2006

This document must be used for training purposes only.

Under no circumstances should this document be used as a reference.

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SYSTEM PRESENTATION

INTRODUCTION

The surfaces are made of composite materials except the slats which are made of aluminium alloy.
All the flight control surfaces are:
- electrically controlled and
- hydraulically operated.

There is a mechanical back-up on the :
- pitch axis (Trimmable Horizontal Stabilizer)
- yaw axis (Rudder).

PITCH

The pitch control is achieved by two elevators and the trimmable horizontal stabilizer.
Elevators are used for short term activity.
The Trimmable Horizontal Stabilizer (THS) is used for long term activity.

ROLL

The roll control is achieved by two ailerons and five spoilers on each wing, numbered from wing root to wing tip.
Operation with the rudder ensures the automatic roll/yaw coordination during turns and dutch roll damping.

YAW

The yaw control is provided by the rudder.
When the rudder is used during T/O, landing roll (crosswind) or to compensate a thrust asymmetry, the roll spoiler and the ailerons prevent enduced roll.

SPEED BRAKE & GROUND SPOILER

The speed brake and ground spoiler functions are achieved by all the spoilers.
The speed brake function is activated to increase the drag.
The ground spoiler function is activated to destroy the lift at touch down and roll-out phase or aborted take-off.

AILERON DROOP

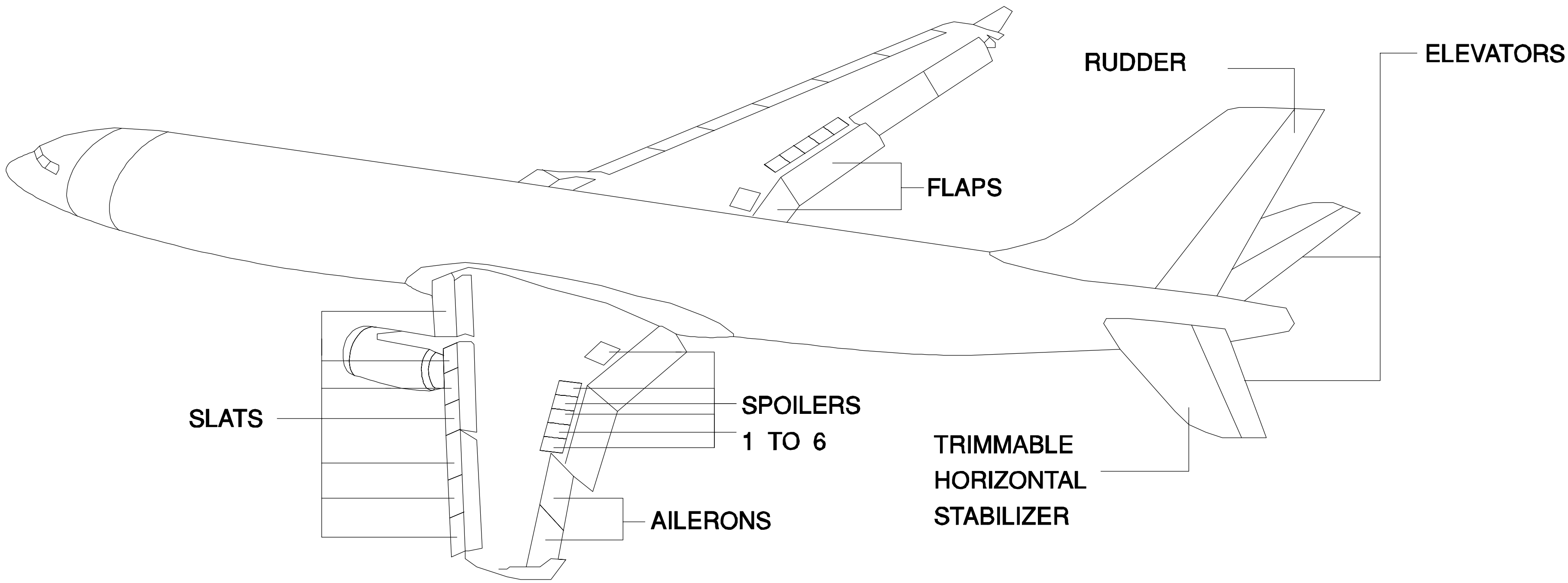
The aileron droop function is provided by all the ailerons. The ailerons are deflected downwards when the flaps are extended to follow the contours of the wing.
The aileron droop function increases the lift on the part of the wing which is not equipped with flaps.

MANEUVER LOAD ALLEVIATION

The maneuver load alleviation function is achieved by two ailerons and three spoilers on each wing.
These surfaces are deflected upwards on both wings.
The purpose of the Maneuver Load Alleviation (MLA) function is to reduce the loads applied to the wing structure during high g maneuver.

HIGH LIFT

The high lift function is achieved by the slats, the flaps and the ailerons.
There are two flaps and seven slats on each wing, numbered from wing root to wing tip.
The slats, in conjunction with the flaps and drooped ailerons, ensure lift augmentation for take-off, approach and landing.



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COMPUTERS

A computer arrangement permanently controls and monitors the flight control surfaces, it also records and stores faults.
This computer arrangement includes three flight control primary computers and two flight control secondary computers able to control the aircraft in the roll, yaw and pitch axis.

- 3 Flight Control Primary Computers (FCPC)
- 2 Flight Control Secondary Computers (FCSC).

In case of failures, one FCPC or one FCSC alone is able to control the aircraft on the three axes.
Two slat and flap control computers are used to control the slats and flaps and two flight control data concentrators permit the indicating and maintenance functions to be achieved.

- 2 Slat / Flap Control Computers (SFCC)
- 2 Flight Control Data Concentrators (FCDC).

Each computer, except the FCDCs, incorporates a bite function.

TURBULENCE DAMPING

The purpose of the Turbulence Damping Function is to damp the structural loads induced by atmospheric turbulence.
The longitudinal and lateral Turbulence Damping commands are computed by FCPC 1 (respectively FCPC 2 and FCPC 3 as a redundancy) as a function of the vertical and lateral acceleration information.
They are added to the normal law command and transmitted to the associated elevator servo-controls and yaw damper system.

SAFETY PRECAUTIONS

Let's present the precautions that have to be taken before operating the flight control surfaces.

WARNING:
Put the safety devices and the warning notice in position.

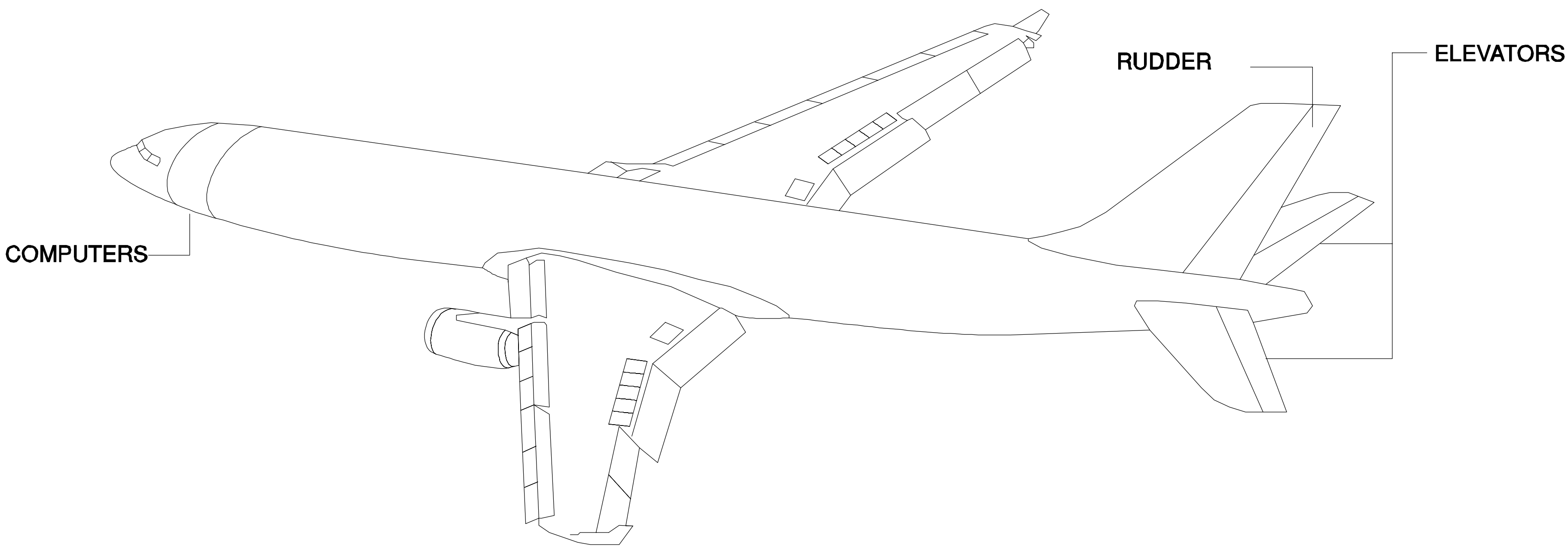
WARNING:
Make sure that the travel ranges of the surfaces are clear before you pressurize/depressurize a hydraulic system.

WARNING:
Make sure that the controls agree with the position of the items they operate before you pressurize a hydraulic system.

WARNING:
Make sure that the landing gear safety locks and the wheel chocks are in position.

MAINTENANCE PRACTICES

In spite of the electrical flight control, rigging has to be performed on the three axes including the flaps and slats.



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STUDENT NOTES:

FLY BY WIRE PHILOSOPHY

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

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

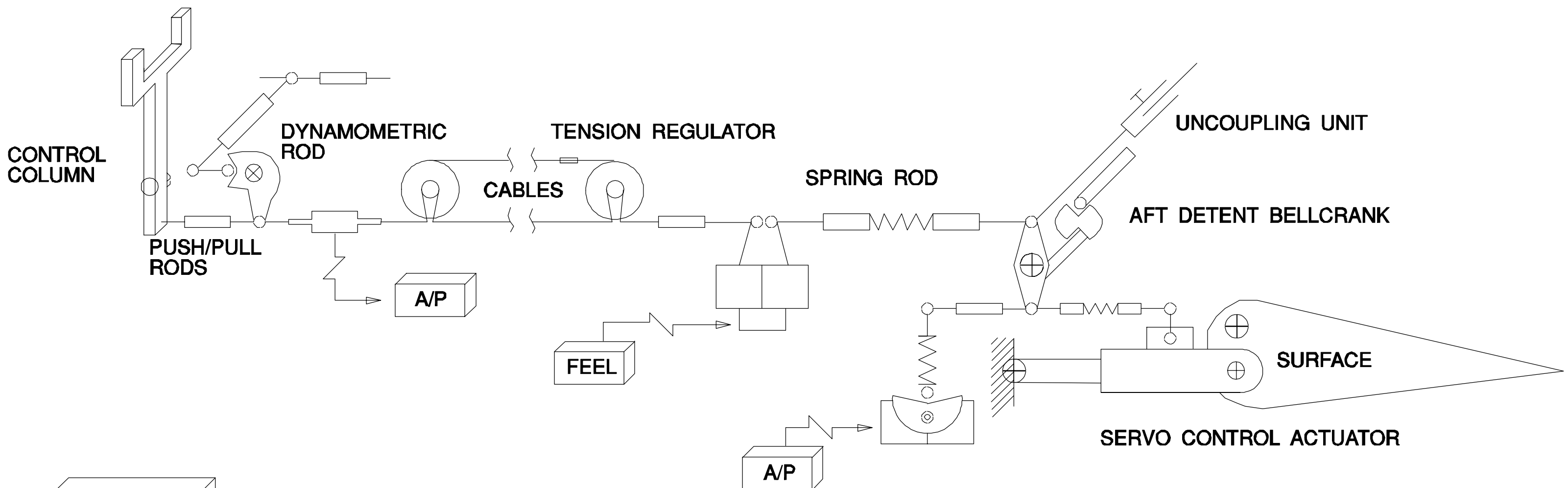
The modulated artificial feel is replaced by the side stick centering spring.

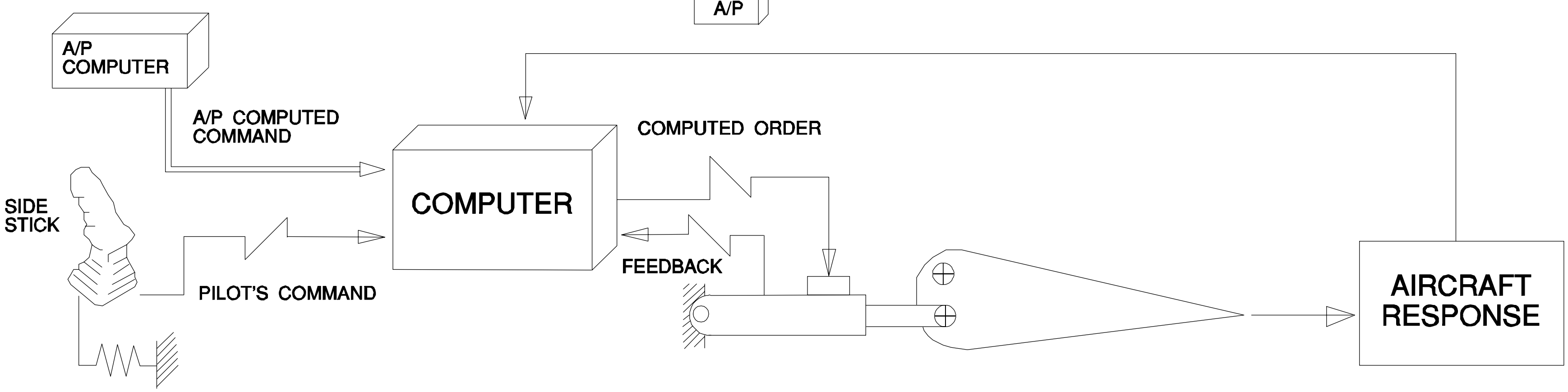
SERVO ACTUATOR

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

CONTROL WHEEL STEERING FUNCTION

The Control Wheel Steering (CWS) function is ensured by the computers which use the aircraft response to maintain the required attitude.





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STUDENT NOTES

SYSTEM CONTROL AND INDICATING

Side Sticks
Speed Brake Lever
THS Mechanical Control
Rudder Pedals
Slat/Flap Control Lever
Rudder Trim
Flight Control Panels
ECAM Pages

SIDE STICKS

The side sticks, one on each lateral console, are used for manual pitch and roll control.
They control the surfaces through the flight control computers.
The handgrip includes two switches, one used for autopilot disconnection or to take priority and the other one for the radio.
For some maintenance procedures, it is necessary to lock the side sticks with a pin in pitch and roll neutral position.

SPEED BRAKE LEVER

The speed brake lever controls the position of the speed brake surfaces and the manual preselection of the ground spoilers.
* To select a required position of the speed brake surface, the lever has to be pushed down and placed in the required position.
A "hard point" is provided at 1/2 speed brake position.
* To arm the ground spoilers the lever must be pulled up when in RET position.
When the lever is armed or reverse thrust is selected, all spoilers will automatically extend at touch down, landing roll or in case of aborted take off.

A "SPEED BRAKES CONFIG" warning is generated if speed brakes are extended with engines not at idle.

THS MECHANICAL CONTROL

Both pitch trim wheels provide mechanical control of the THS and have priority over electrical control. The THS mechanical control must be used when the automatic pitch trim is not available.
Trim position is indicated in degrees on a scale adjacent to each trim wheel.
At landing, when the main landing gear legs are compressed and when the pitch attitude is lower than a given value, the pitch trim wheels return automatically to the middle of the green band.

RUDDER PEDALS

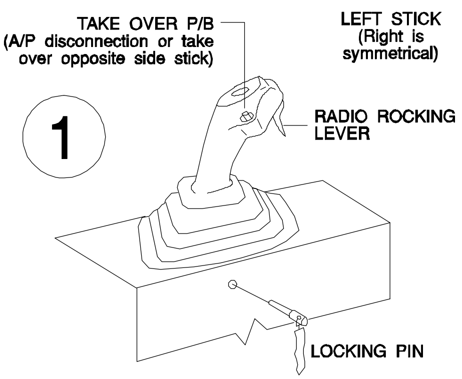
Two sets of pedals provide rudder mechanical control.
These pedals have an individual adjustment device to suit pilot morphology.

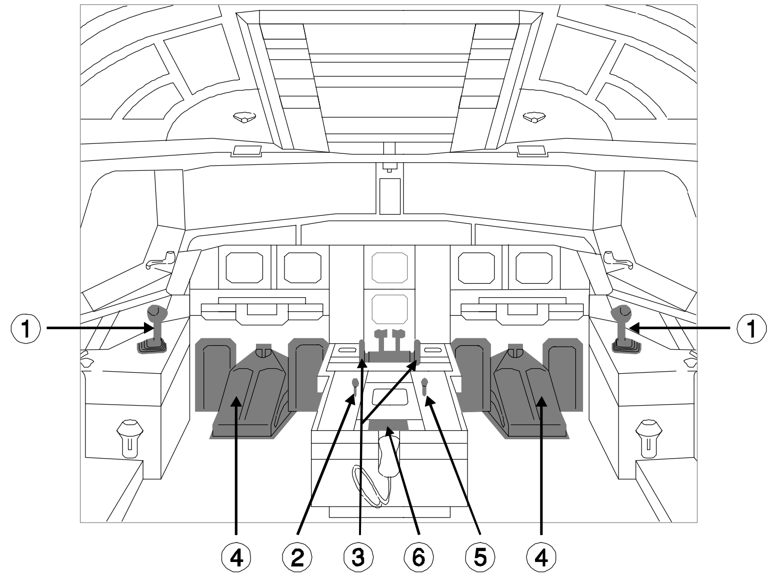
SLAT/FLAP CONTROL LEVER

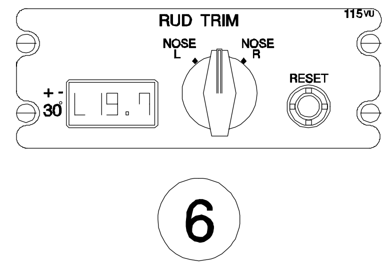
The lever is connected to the command sensor unit which translates the mechanical demand into electrical signals for the Slat Flap Control Computers.
The flaps lever selects simultaneous operation of slats and flaps and must be pulled out of the detent before selection of any position.
The five lever positions correspond to the following surface positions (see table).

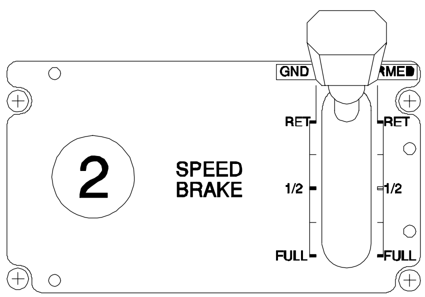
RUDDER TRIM

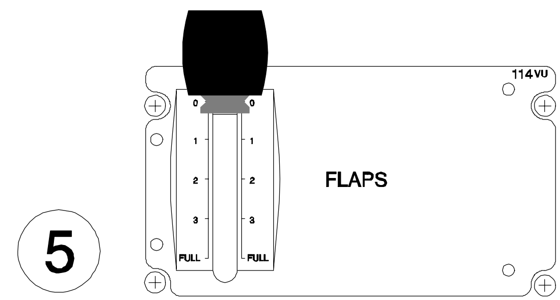
The rudder trim order is transmitted to the trim actuator through the FCSCs.
1 - Rudder trim reset pushbutton switch (Resets the trim position to zero).
2 - Rudder trim control switch (Controls the rudder trim actuator which moves the neutral point of the artificial feel).
3 - Rudder trim indicator (Displays rudder trim direction L or R and value 0 to 29.9°).



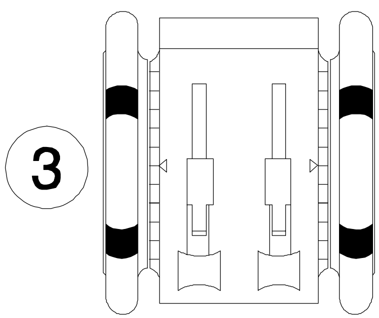


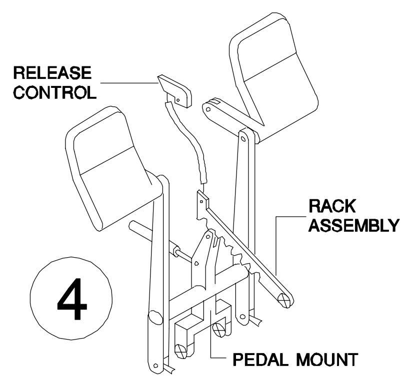






LEVER POSITION	FLIGHT PHASE
0	CRUISE
1	HOLD
1+F	TAKE OFF
2	T/O APPROACH
3	T/O APPR LDG
FULL	LANDING





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FLIGHT CONTROL PANELS

- COMPUTER PUSHBUTTONS

The computer pushbuttons serve to energize, de-energize and reset the Flight Control Primary Computers and the Flight Control Secondary Computers.

OFF/R : In white when the corresponding computer is not active.

FAULT : Comes on amber accompanied by an ECAM caution activation when a failure is detected.
The FAULT light goes off when OFF is selected.
PRIM = Flight Control Primary Computers,
SEC = Flight Control Secondary Computers.

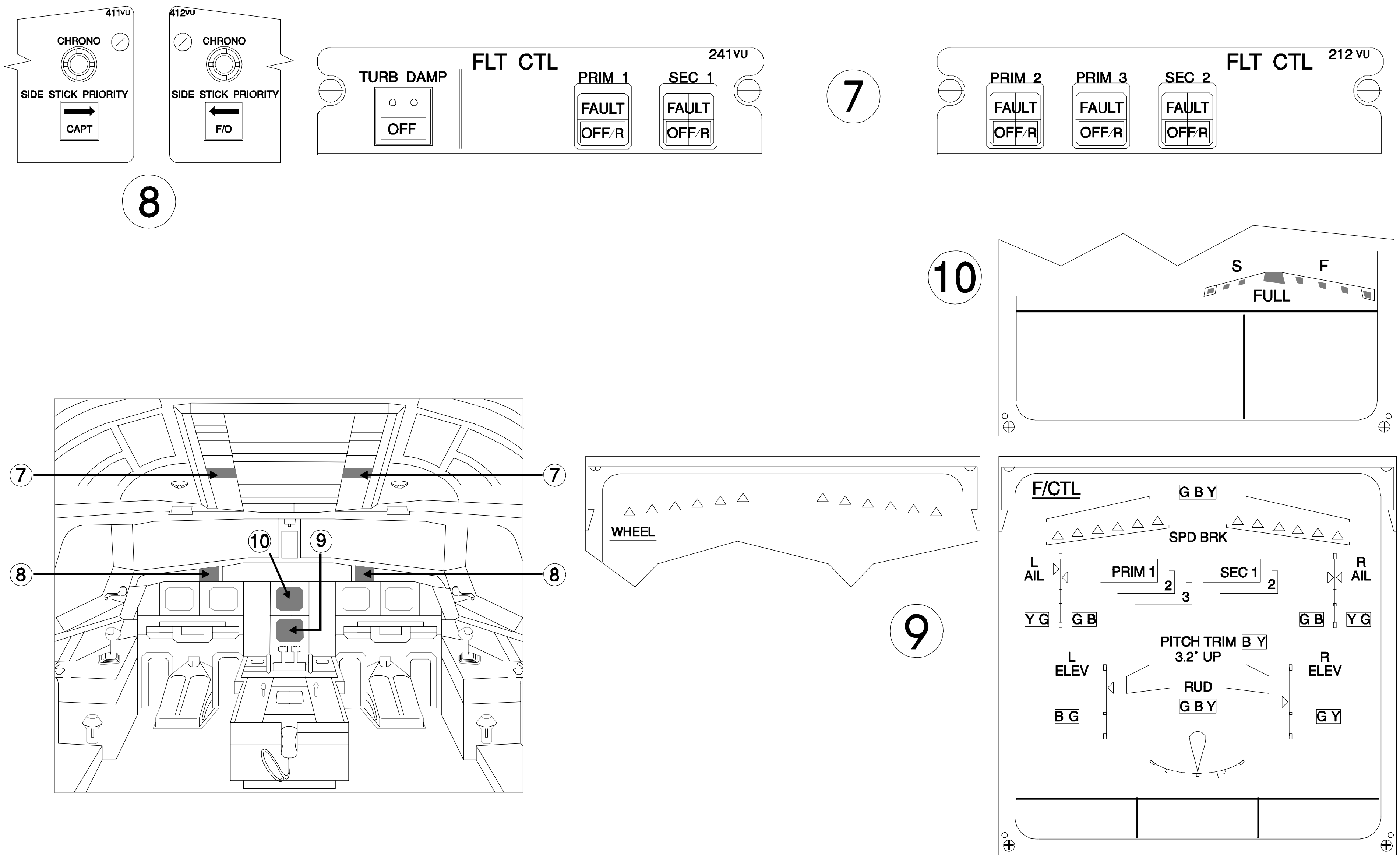
OFF : In white in case of failure or turbulence p/b switch selected to OFF position. "TURB. DAMP OFF" blue memo appears on the ECAM.

- SIDE STICK PRIORITY LIGHTS

The side stick priority lights indicate the loss of priority and the taking of priority in front of the pilots.
The red arrow light comes on in front of the pilot losing priority.
CAPT or F/O green light, comes on in front of the pilot taking priority if the other side stick is not at neutral.

ECAM PAGES

The flight control system uses three ECAM pages, the flight control ECAM page and the wheel ECAM page for the primary surface indications, and the engine warning display for the slat and flap indications.



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STUDENT NOTES

FLIGHT CONTROLS WARNINGS & OPERATING LIMITATIONS

Primary Flight Control Warnings
Secondary Flight Control Warnings
Operating Limitations

PRIMARY FLIGHT CONTROL WARNINGS

CONFIG
- SPEED BRAKE NOT RETRACTED or
- PITCH TRIM NOT IN T.O RANGE (-7 deg, -1 deg)
- RUDDER TRIM NOT IN T.O RANGE (+3 deg)
A/C not in take off configuration when thrust levers are set at T.O or Flex T.O or when "T.O CONFIG" pushbutton is pressed.

CONFIG L (R) SIDESTICK FAULT
Left or right sidestick is inoperative (deactivated by takeover pushbutton) when thrust levers are set at T.O or Flex T.O or when "T.O CONFIG" pushbutton is pressed.

L+R ELEVATOR FAULT
Both elevators are lost.
Only manual pitch trim is available.
Note the message on both PFDs.

L (R) SIDESTICK FAULT
Transducers on pitch or roll axis have failed on one sidestick.

PRIM 1 (2) (3) FAULT
Failure of one Primary computer (FCPC).

SEC 1 (2) FAULT
Failure of one Secondary computer (FCSC).

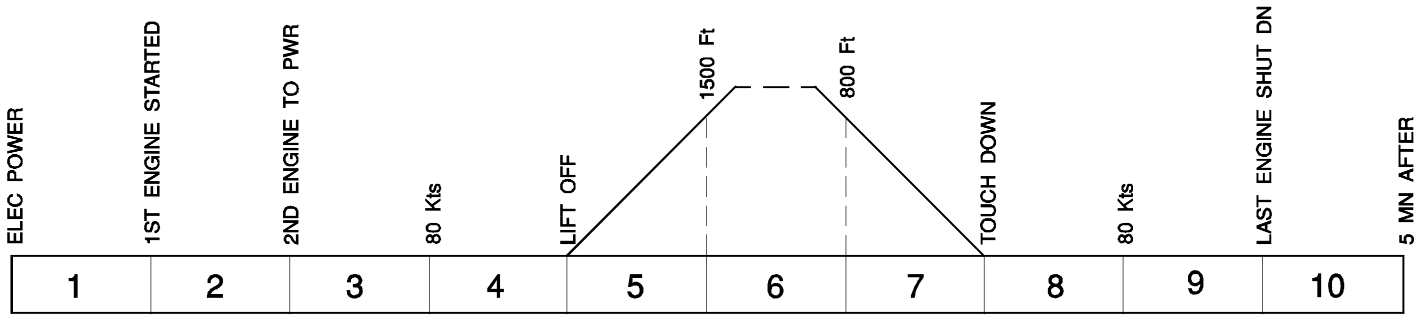
FCDC 1 + 2 FAULT
Failure of both Flight Control Data Concentrators.

DIRECT LAW
Direct laws are active.

ALTERNATE LAW
Alternate laws are active.

IR DISAGREE
Disagreement between two IR, the third one having failed.

ADR DISAGREE
Disagreement between two ADR, the third one having failed.



<table>
<tr><th>E / WD - FAILURE TITLE
Conditions</th><th>AURAL WARNING</th><th>MASTER LIGHT</th><th>SD PAGE CALLED</th><th>LOCAL WARNING</th><th>FLIGHT PHASE INHIB</th></tr>
<tr><td>CONFIG
- SPD BRK NOT RETRACTED or
- PITCH TRIM NOT IN T.O RANGE (-7 deg, -1 deg)
- RUD TRIM NOT IN T.O RANGE (+ 3 deg)</td><td rowspan="3">CRC</td><td rowspan="3">MASTER WARNING</td><td>F/CTL</td><td>NIL</td><td>5, 6, 7, 8</td></tr>
<tr><td>CONFIG L (R) SIDESTICK FAULT</td><td>NIL</td><td>NIL</td><td>5, 6, 7, 8</td></tr>
<tr><td>L + R ELEV FAULT</td><td rowspan="5">F/CTL</td><td>PFD MESSAGE</td><td rowspan="2">NIL</td></tr>
<tr><td>L (R) SIDESTICK FAULT</td><td rowspan="8">SINGLE CHIME</td><td rowspan="8">MASTER CAUTION</td><td>NIL</td></tr>
<tr><td>PRIM 1 (2) (3) FAULT</td><td>FAULT lt on PRIM pb</td><td>3, 4, 5, 7, 8</td></tr>
<tr><td>SEC 1 (2) FAULT</td><td>FAULT lt on SEC pb</td><td>3, 4, 5</td></tr>
<tr><td>FCDC 1 + 2 FAULT</td><td>NIL</td><td>4, 5, 7, 8</td></tr>
<tr><td>DIRECT LAW</td><td rowspan="4">NIL</td><td>PFD MESSAGE</td><td rowspan="2">4, 5, 7, 8</td></tr>
<tr><td>ALT LAW</td><td>NIL</td></tr>
<tr><td>IR DISAGREE</td><td>PFD MESSAGE</td><td rowspan="2">4, 5, 7, 8</td></tr>
<tr><td>ADR DISAGREE</td><td>NIL</td></tr>
</table>

GROUND SPOILER FAULT
Loss of ground spoiler function in all Primary computers.

SPEED BRAKE DISAGREE
Disagreement between the speed brake handle and the surface position.
Speed brakes should be retracted and not used for the rest of the flight.

SPEED BRAKE FAULT
Speed brake lever transducers to all Primary computers have failed.

STABILIZER CONTROL FAULT
Electrical control of the THS is lost.
Manual pitch trim may be available.

L (R) ELEVATOR FAULT
Loss of both servojacks on one elevator.

L (R) OUTER (INNER) AILERON FAULT
Loss of both servojacks on one aileron.

SPOILER FAULT
Loss of one or more spoilers.

RUDDER TRIM FAULT
Rudder trim systems 1 and 2 are inoperative.

RUDDER TRAVEL LIMITER FAULT
Rudder travel limiters 1 and 2 are faulty.
Use rudder with care above 160 kts.

YAW DAMPER FAULT
Loss of both yaw damper servoactuators.

ELEVATOR REDUNDANCY LOST
Appears in case two of the following conditions are met:

- PRIM 2 failed (FCPC2)
- SEC 2 failed (FCSC2)
- G HYD SYS LO PR.

SENSOR FAULT
Loss of any sensor of the flight control system.

ELEVATOR SERVO FAULT
Loss of one servojack on one elevator.

AILERON SERVO FAULT
One aileron servocontrol is lost, (here Blue servocontrol on the left inboard aileron).
Note that the remaining servocontrol, (here Green) becomes automatically active.

FCDC 1 (2) FAULT
Failure of one FCDC.

YAW DAMPER 1 (2)
One of the two yaw damper servoactuators is lost.

RUDDER TRIM 1 (2) FAULT
Rudder trim system 1 or 2 is inoperative.

RUDDER TRAVEL LIMITER 1 (2) FAULT
Rudder travel limiter 1 or 2 is faulty.

RUDDER BLUE (GREEN) (YELLOW) SERVO JAM
One of the rudder hydraulic servojacks is inoperative.

PRIM 1 (2) (3) SEC 1 (2) PITCH FAULT
Failure of pitch channel in the associated computer.

TURBULENCE DAMPER FAULT
The turbulence damping system is inoperative.

E / WD - FAILURE TITLE Conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLIGHT PHASE INHIB
GND SPLR FAULT	SINGLE CHIME	MASTER CAUTION	F/CTL	NIL	3, 4, 5
SPD BRK DISAGREE					3, 4, 5, 7, 8
SPD BRK FAULT					
STAB CTL FAULT					4, 5
L (R) ELEV FAULT					
L (R) OUTR (INR) AIL FAULT					
SPLR FAULT					3, 4, 5, 7, 8
RUD TRIM FAULT					4, 5, 7, 8
RUD TRV LIM FAULT					
YAW DAMPER FAULT			NIL		4, 5, 8
ELEV REDUND LOST					1, 4, 5, 7, 8, 10
SENSOR FAULT					3, 4, 5, 6, 7, 8
ELEV SERVO FAULT	NIL	NIL	F/CTL		3, 4, 5, 7, 8
AIL SERVO FAULT					3, 4, 5, 7, 8
FCDC 1 (2) FAULT			NIL		
YAW DAMPER 1 (2)					3, 4, 5, 7, 8
RUD TRIM 1 (2) FAULT					3, 4, 5, 7, 8
RUD TRV LIM 1 (2)					
RUD B (G) (Y) SERVO JAM					
PRIM 1 (2) (3) SEC 1 (2) PITCH FAULT					3 to 8
TURB DAMP FAULT					3, 4, 5, 7, 8

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SECONDARY FLIGHT CONTROL WARNINGS

SLATS (FLAPS) NOT IN T.O CONFIGURATION

The slats (flaps) are not in take off config and the thrust levers are set to TOGA or FLX.
The same warning appears when the "Take Off Config" pushbutton is pressed, or when pitch trim or rudder trim are not in take off range.

SLATS (FLAPS) FAULT

Both slat position detection channels have failed and flap extension must be limited by the pilot.

SLATS (FLAPS) LOCKED

The slat wing tip brakes are activated.
Further slat operation is inhibited while flap operation remains possible.
Similarily, if "FLAPS LOCKED" occurs, the flaps cannot be moved but slat operation is still available.

LEVER OUT OF DETENT

The slat/flap lever is between two detents and a proper surface position cannot be selected.

SLAT SYSTEM 1 (2) FAULT

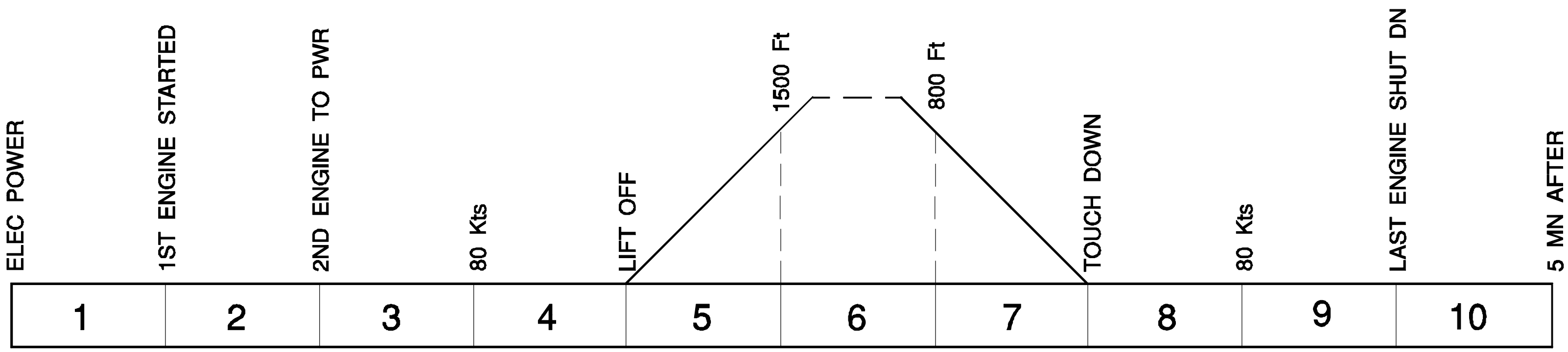
Failure of one slat channel in one SFCC.

FLAP SYSTEM 1 (2) FAULT

Failure of one flap channel in one SFCC.

SLAT (FLAP) WING TIP BRAKE FAULT

Failure of one wing tip brake on slats or flaps.



E / WD - FAILURE TITLE Conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLIGHT PHASE INHIB
CONFIG SLATS (FLAPS) NOT IN T.O CONFIG	CRC	MASTER WARNING			5, 6, 7, 8
SLATS (FLAPS) FAULT					4, 5, 8
SLATS (FLAPS) LOCKED					
FLAP / MCDU DISAGREE	SINGLE CHIME	MASTER CAUTION	NIL	NIL	1, 2, 5, 6, 7, 8, 9, 10
LVR OUT OF DETENT					NIL
SLAT SYS 1 (2) FAULT					3, 4, 5, 7, 8
FLAP SYS 1 (2) FAULT	NIL	NIL			
SLAT (FLAP) WING TIP BRK FAULT					3, 4, 5, 6, 7, 8

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OPERATING LIMITATIONS

For dispatch, aircraft should be in Normal Law.
One Primary and one Secondary computers may be inoperative, provided information from other computers is available (SFCCs, ADIRs...).

Flight controls limitations are:

- Max load factor
  - +2.5g to -1g slats retracted
  - +2g to 0g slats extended

- Vmo 330 kt, Mmo 0.86

Max Flap/Slat speeds are written on the Speed limit placard located on the main instrument panel.
In addition they are displayed on the PFD speed scale.

Flight controls limitations are:

- Max crosswind
  - for take-off: 32 kts
  - for landing: 32 kts
  - in gust: 40 kts

- Max tail wind: 10 kts

- VMCA: 117 kts

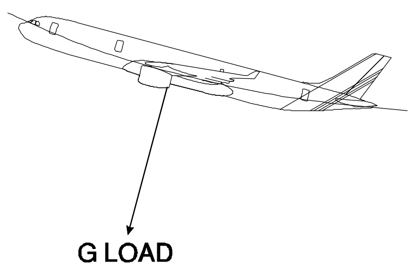
- VMCG: 118 kts

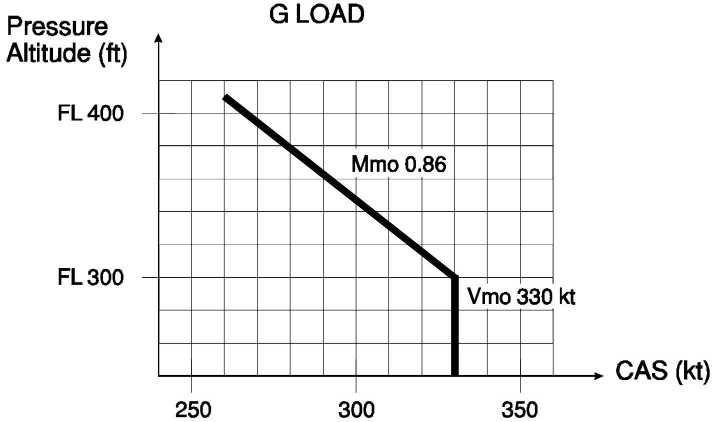
In alternate law:
Max speed/Mach is 330 kt/0.82

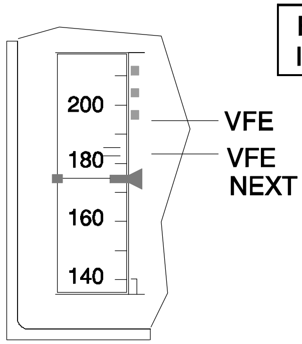
In direct law:
Max speed/Mach is 330 kt/0.80
Maneuver with care.

Mechanical back-up:
Mechanical back-up is a temporary measure to be used until control through computers is re-established.

FLIGHT CONTROL WARNINGS AND OPERATING LIMITATIONS







FOR INFO

MAX FLAP / SLAT SPEEDS

POS	SPD	REMARKS
1	240	INT. APPROACH
1+F	215	TAKE OFF
2	196	T.O / APPR
3	186	T.O / APPR / LDG
FULL	180	LANDING

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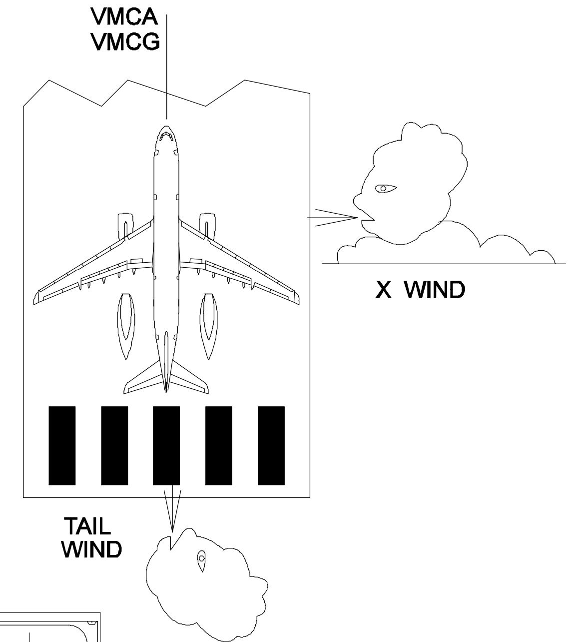
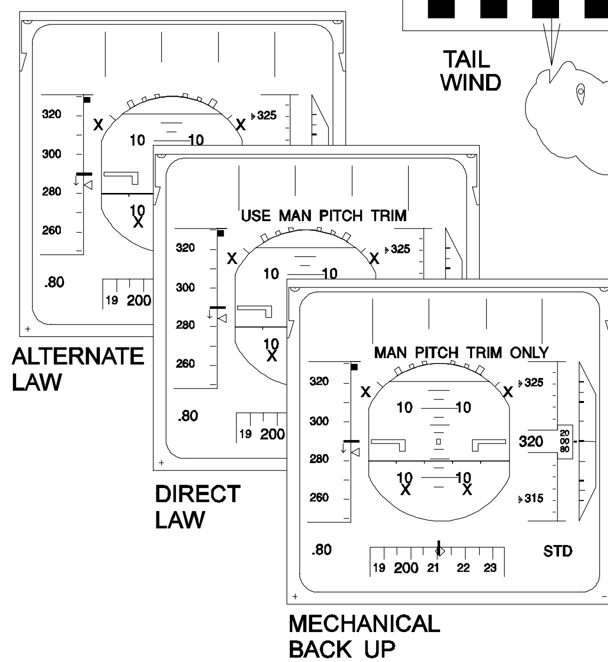
FLIGHT CONTROL WARNINGS AND OPERATING LIMITATIONS





STUDENT NOTES

EFCS PRESENTATION

Surfaces
Actuators
Computers
Priority Servocontrols
Reconfiguration Priorities

SURFACES

All the flight control surfaces are hydraulically operated by actuators which are electrically signalled by the computers. The rudder and the Trimmable horizontal Stabilizer(THS) can also be mechanically signalled. In case of total electrical failure, the Back up Yaw Damper Unit (BYDU) provides yaw damping on the rudder.

ACTUATORS

All the actuators are hydraulically powered by one of the three hydraulic circuits, except the rudder trim actuator, the rudder travel limitation unit (RTLU), the pedal travel limitation unit (PTLU) and the THS servo- motors which are electrically driven.

COMPUTERS

The relationship between actuators and computers is indicated on the schematic. The inboard aileron actuators, the yaw damper actuators and the elevator actuators are connected to two computers, one FCPC and one FCSC

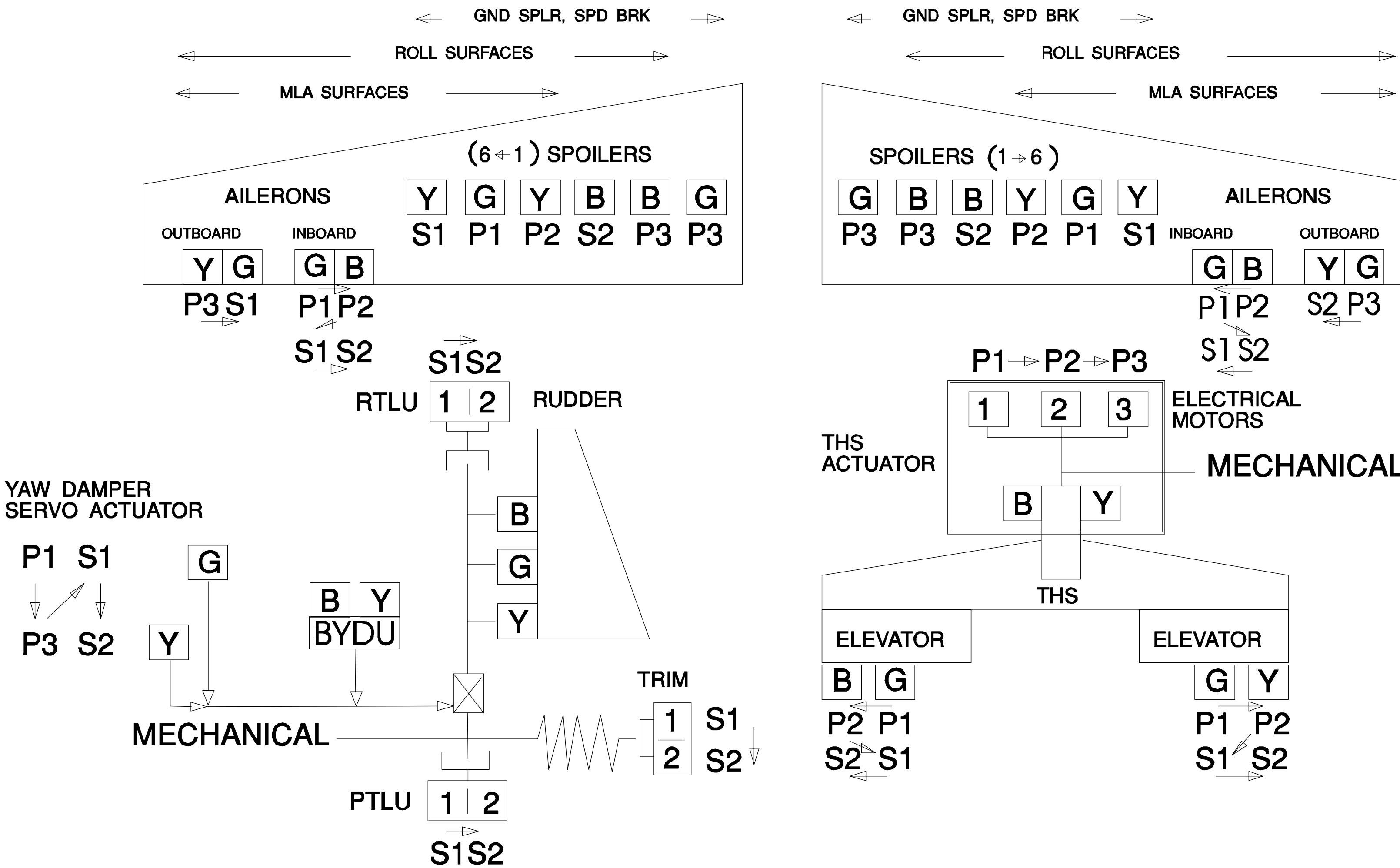
P : FCPC (Flight Control Primary Computer)
S : FCSC (Flight Control Secondary Computer)

PRIORITY SERVOCONTROLS

There are two servocontrols for each aileron , for each elevator and for the yaw damping function. In normal configuration, one servocontrol actuates the surface. It's called priority servocontrol and is in active mode. The second, which follows the surface deflection, is in damping mode.

RECONFIGURATION PRIORITIES

In normal configuration, the following computers ensure the servoloop control. The amber arrows indicate the actuation reconfiguration priorities in case of computer failure or loss of hydraulic circuits..



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STUDENT NOTES:

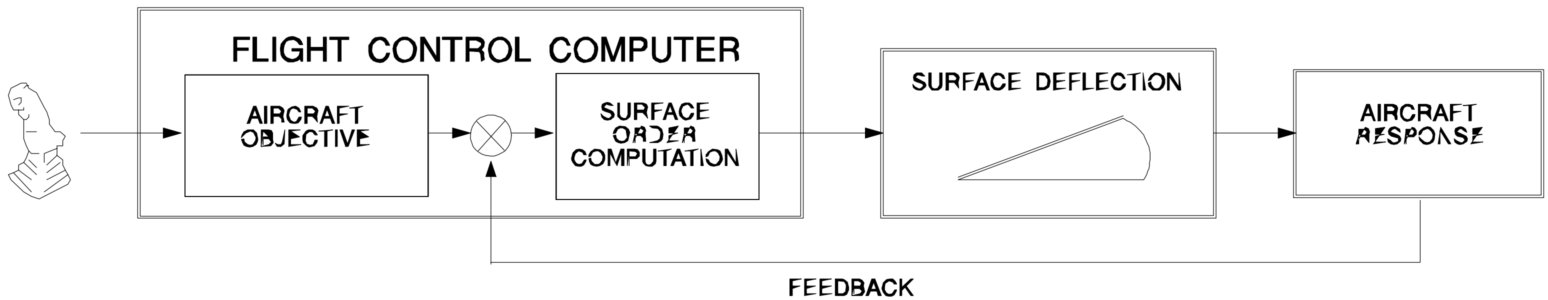
CONTROL LAW PRESENTATION

Normal Laws
Laws Reconfiguration
Alternate Laws
Direct Laws
Mechanical Back-up
Control Law Implementation

NORMAL LAWS

In normal conditions, the normal laws are used to compute the surface deflection orders.

BASIC PRINCIPLE



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There are three principal control modes, the ground mode, the flight mode and the flare mode.

During the ground mode, a direct relationship exists between the stick, elevators and roll control surfaces. Also, the rudder is mechanically controlled by the pedals and the yaw damper function is available. The ground mode is activated after the flare mode when the main landing gear shock absorbers are compressed with pitch attitude confirmation.

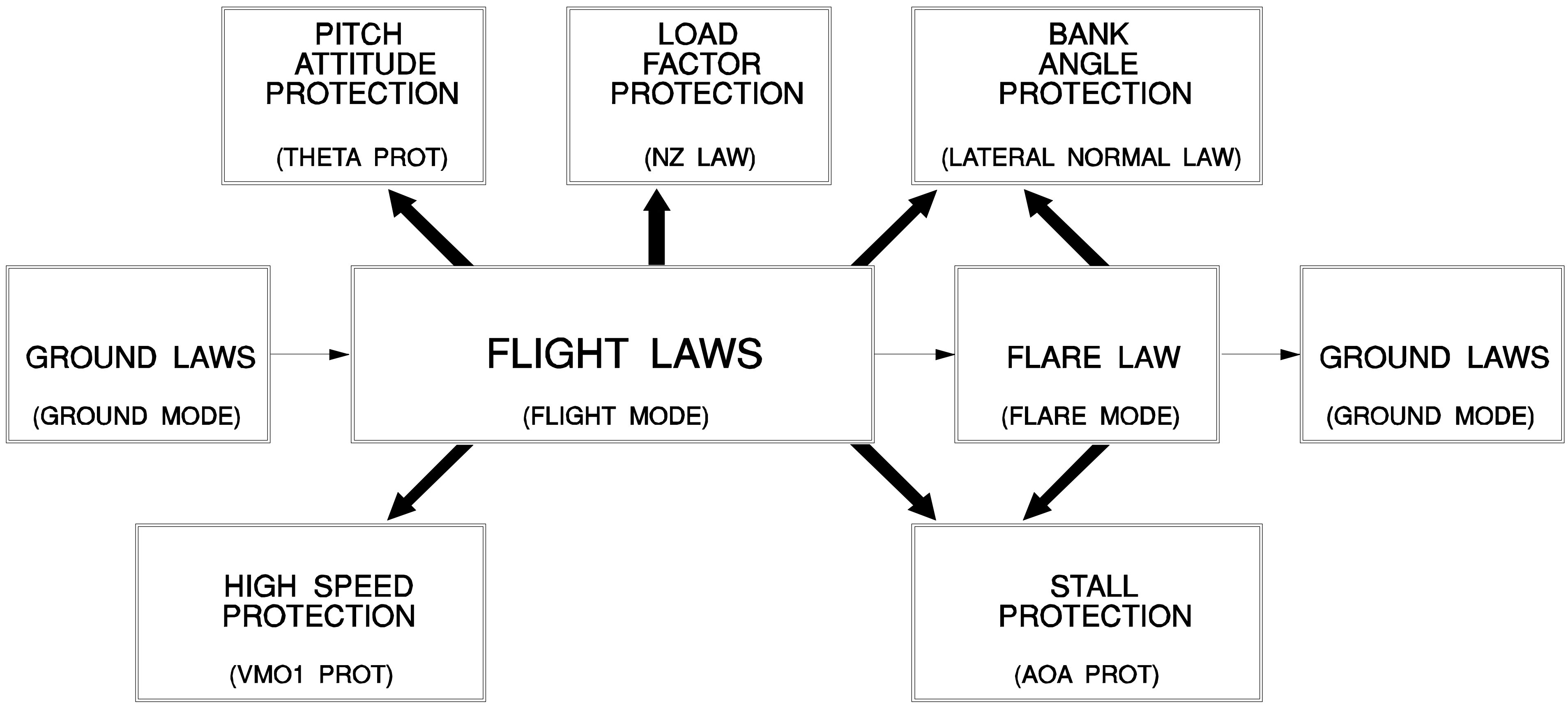
In flight mode, the NORMAL LAWS are :

- Nz law for the pitch control, including load factor protection
- lateral normal law for the lateral control (roll+yaw), including bank angle protection,
- highspeed (VMO), pitch attitude(Theta) and stall(Angle Of Attack) protections.

The flight mode is activated after the ground mode when the main landing gear shock absorbers are extended with pitch attitude confirmation.
The NORMAL LAWS in flare mode are :

- flare law in place of Nz law for the pitch control to allow conventional flare, lateral normal law and stall protection.

  The flare mode is activated after the flight mode below a certain altitude.



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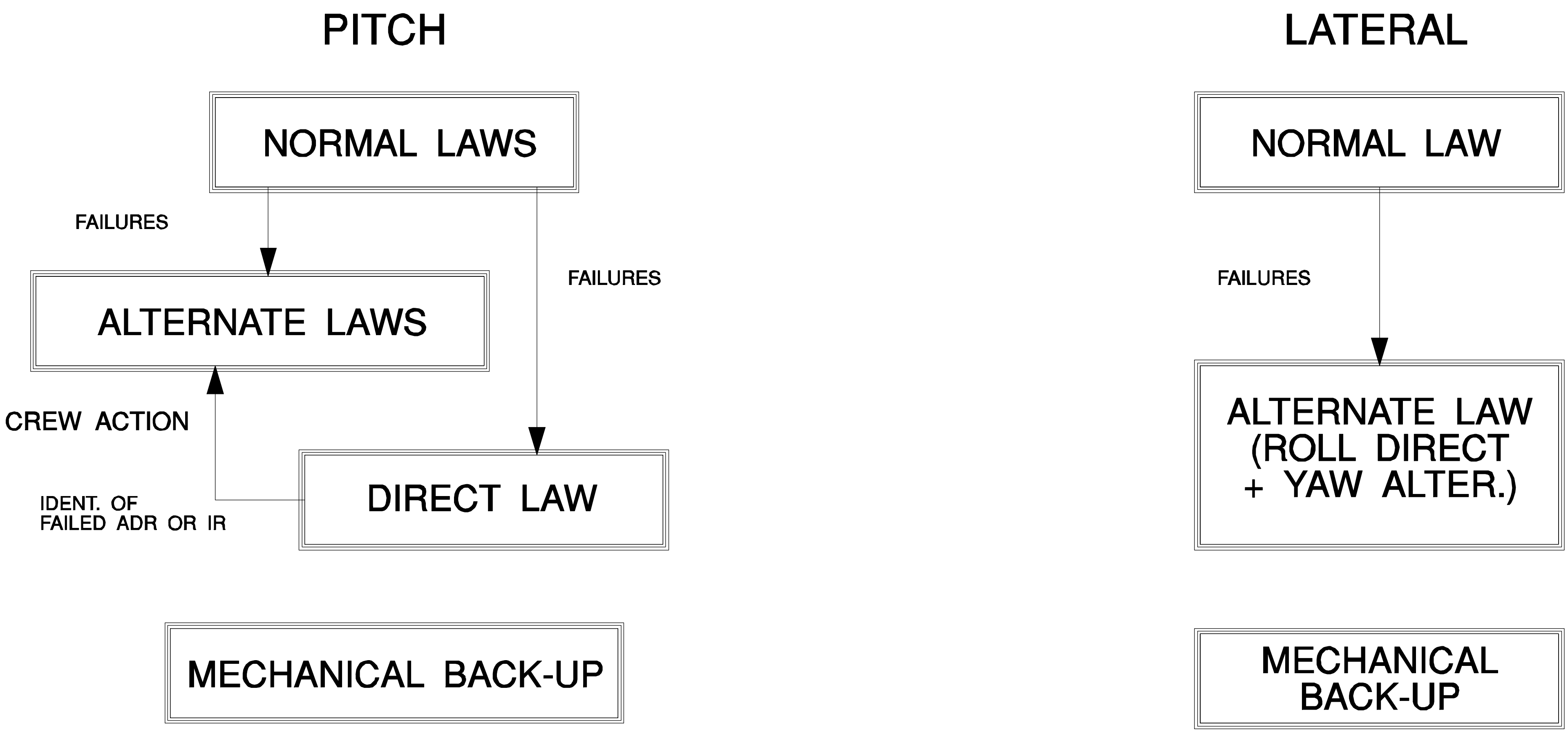
LAWS RECONFIGURATION

After loss of normal laws, the reconfiguration of control laws is different for pitch axis and for lateral axis.
Control law reconfigurations are divided into two families :

- ALTERNATE
- DIRECT

There is no loss of normal law after a single failure.
The transfert from normal laws to alternate laws is automatic and depends on the number and nature of failures.



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ALTERNATE LAWS

There are several degraded laws which are called alternate laws.
Their selection depends on the loss of the inputs such as ADR (Air Data Reference), IR (Inertial Reference), surface control and positions.

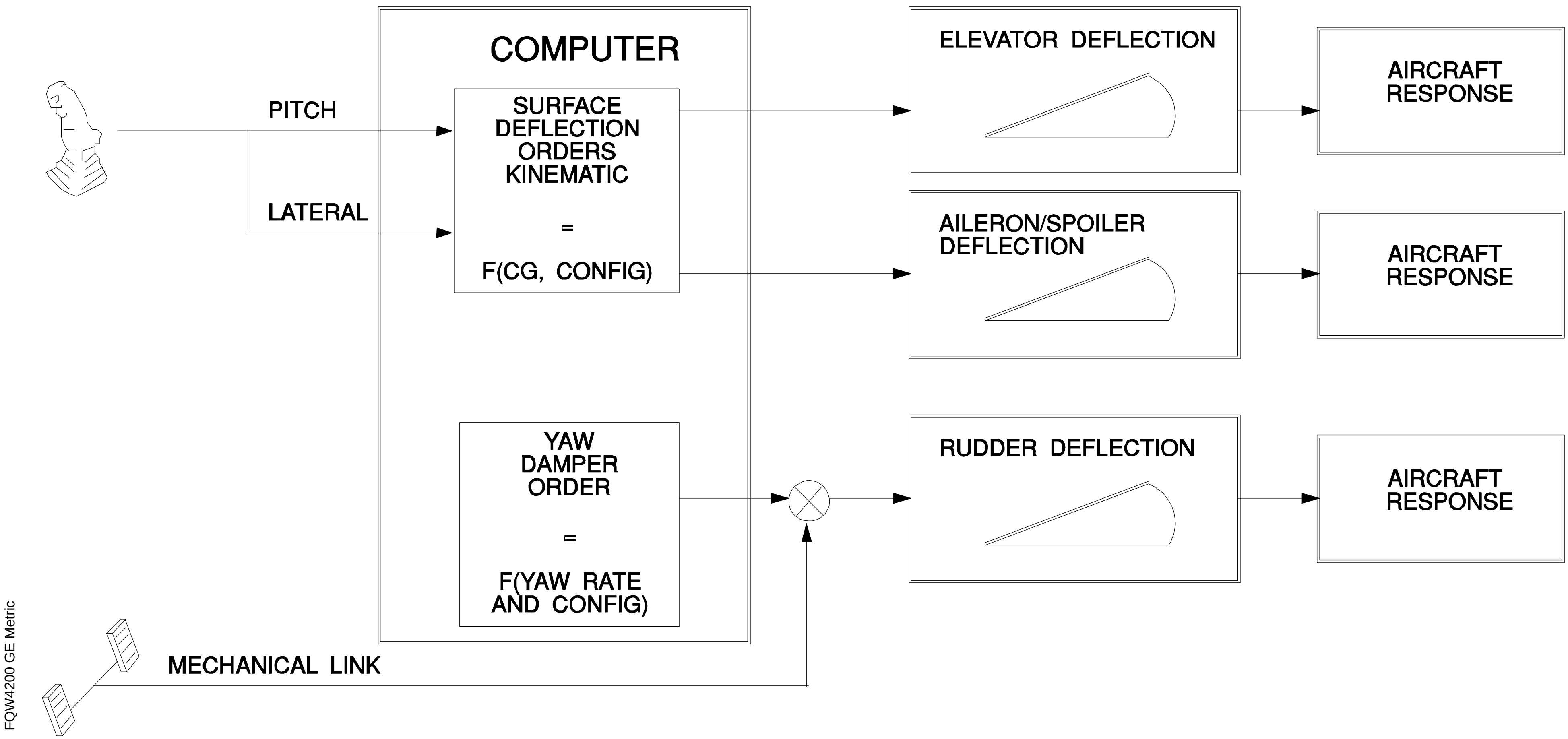
- alternate 1, the pitch attitude protection is lost, high speed and stall protections are alternate.
- alternate 1A, in addition the stall protection is lost.
- alternate 2, the pitch attitude is lost and the high speed and stall protection are alternate, in addition the lateral normal law is lost and replaced by the lateral alternate law (roll direct and yaw alternate).
- alternate 2A, in addition the stall protection is lost.
- alternate 2B, pitch attitude, high speed and stall protection are lost and the lateral normal law is replaced by lateral alternate law (bank angle protection lost).

DIRECT LAWS

In direct laws, all the protections are lost.
In flight mode and in flare mode :

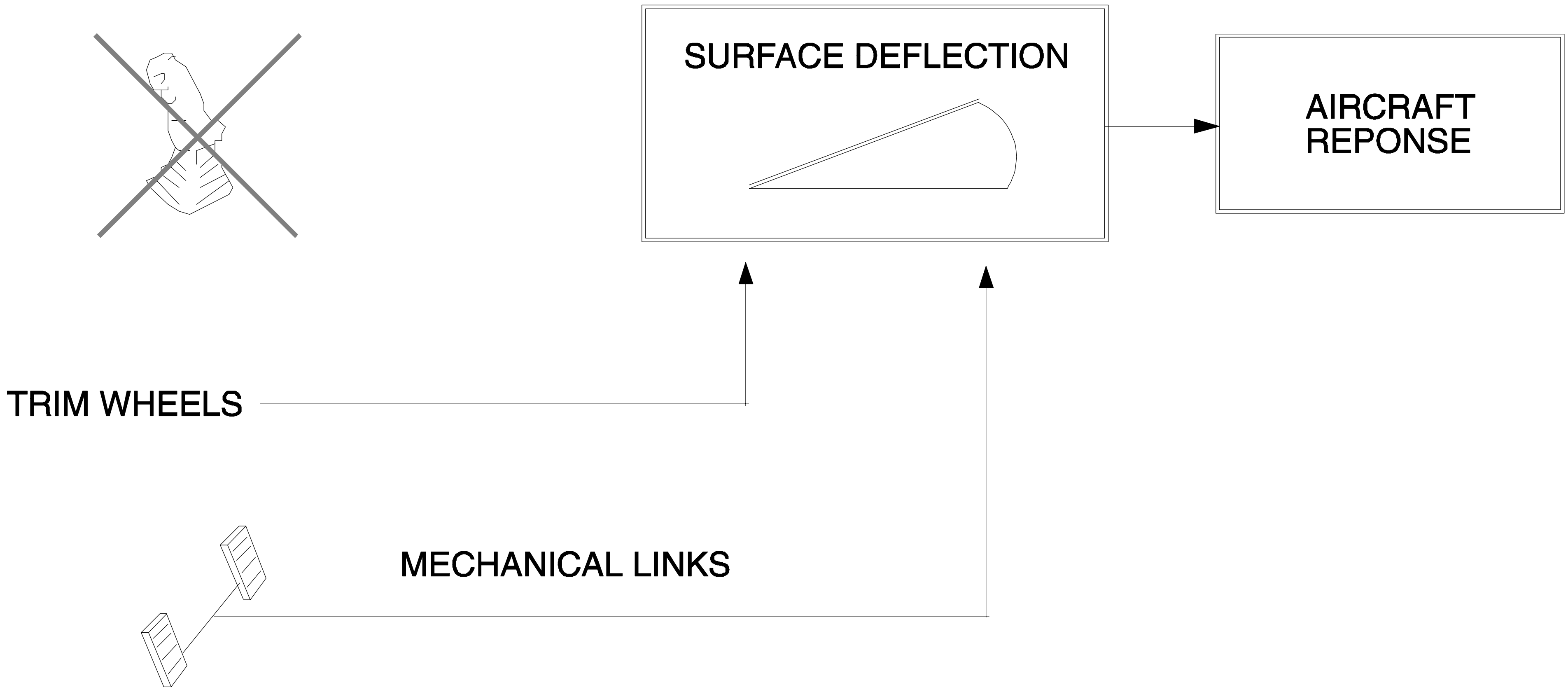
- direct law for the pitch and for the roll axis
- alternate law for the yaw axis.

BASIC PRINCIPLE



MECHANICAL BACK-UP

The mechanical back-up permits the aircraft to be controlled during a temporary complete loss of electrical power.
The longitudinal control is achieved using the trim wheels as the elevators are kept at zero deflection.
The lateral control is achieved from pedals.



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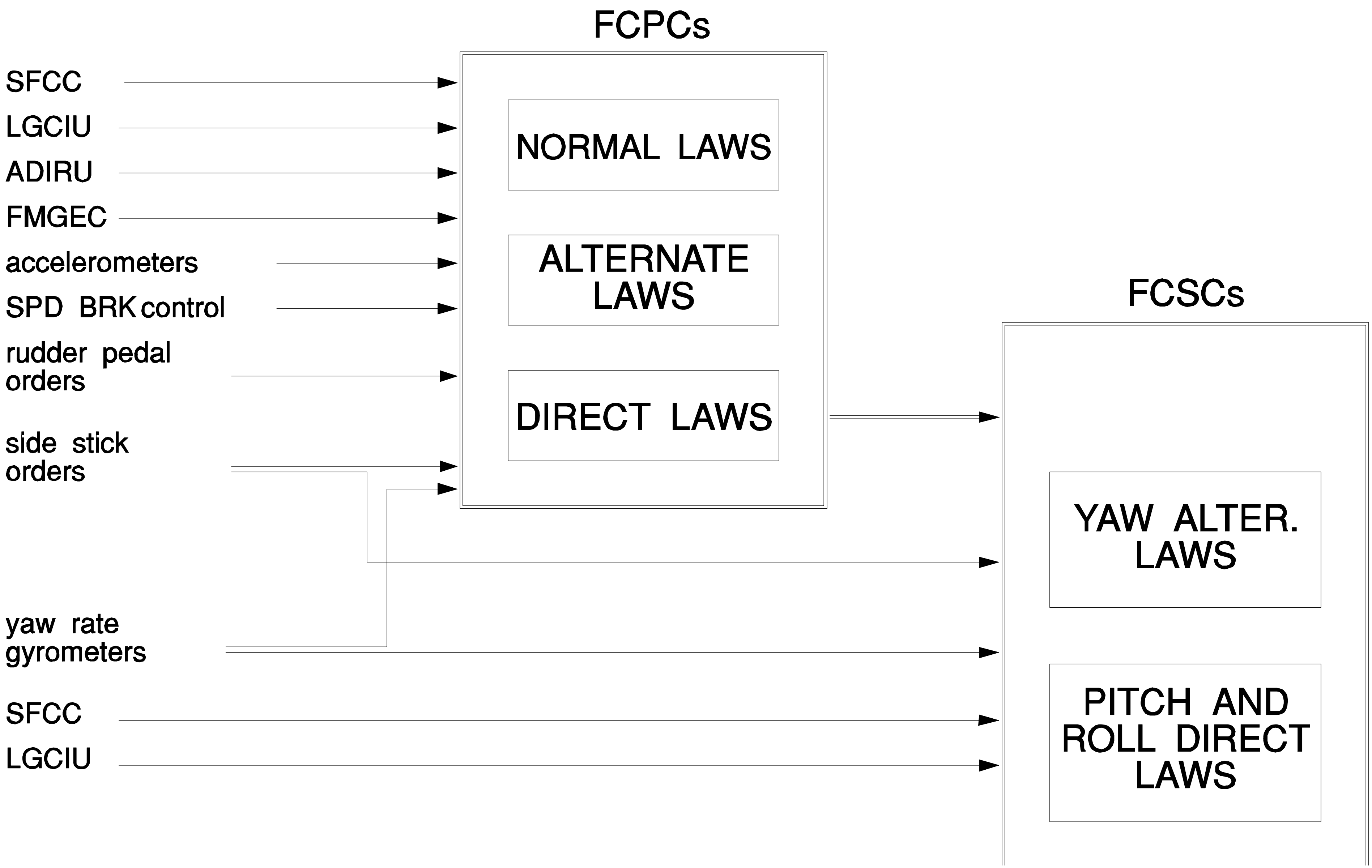
CONTROL LAW IMPLEMENTATION

The normal laws are only implemented in the FCPCs.
The FCSCs can only compute the yaw alternate law and the pitch and roll direct laws.
To compute these laws, the computers require various inputs transmitted by the flight control system or the other systems.



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STUDENT NOTES:

FLIGHT CONTROL COMPUTER PRESENTATION

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GENERAL

The 3 FCPCs and the 2 FCSCs elaborate the orders for the surfaces to permit aircraft control by the crew or by the autopilot.
The FCDCs serve as an interface between the flight control computers and the other aircraft systems

FCPC (1, 2 OR 3)

- LAW CALCULATION
- SERVOLOOP CONTROL AND MONITORING
- SERVOLOOP ENGAGEMENT AND LAW ENGAGEMENT
- SELF MONITORING AND FAILURE INDICATING
- INPUT VALIDATION
- CARACTERISTIC SPEED COMPUTATION

FCSC (1 OR 2)

- LAW CALCULATION
- SERVOLOOP CONTROL AND MONITORING
- SERVOLOOP ENGAGEMENT AND LAW ENGAGEMENT
- SELF MONITORING AND FAILURE INDICATING
- INPUT VALIDATION

FCDC (1 OR 2)

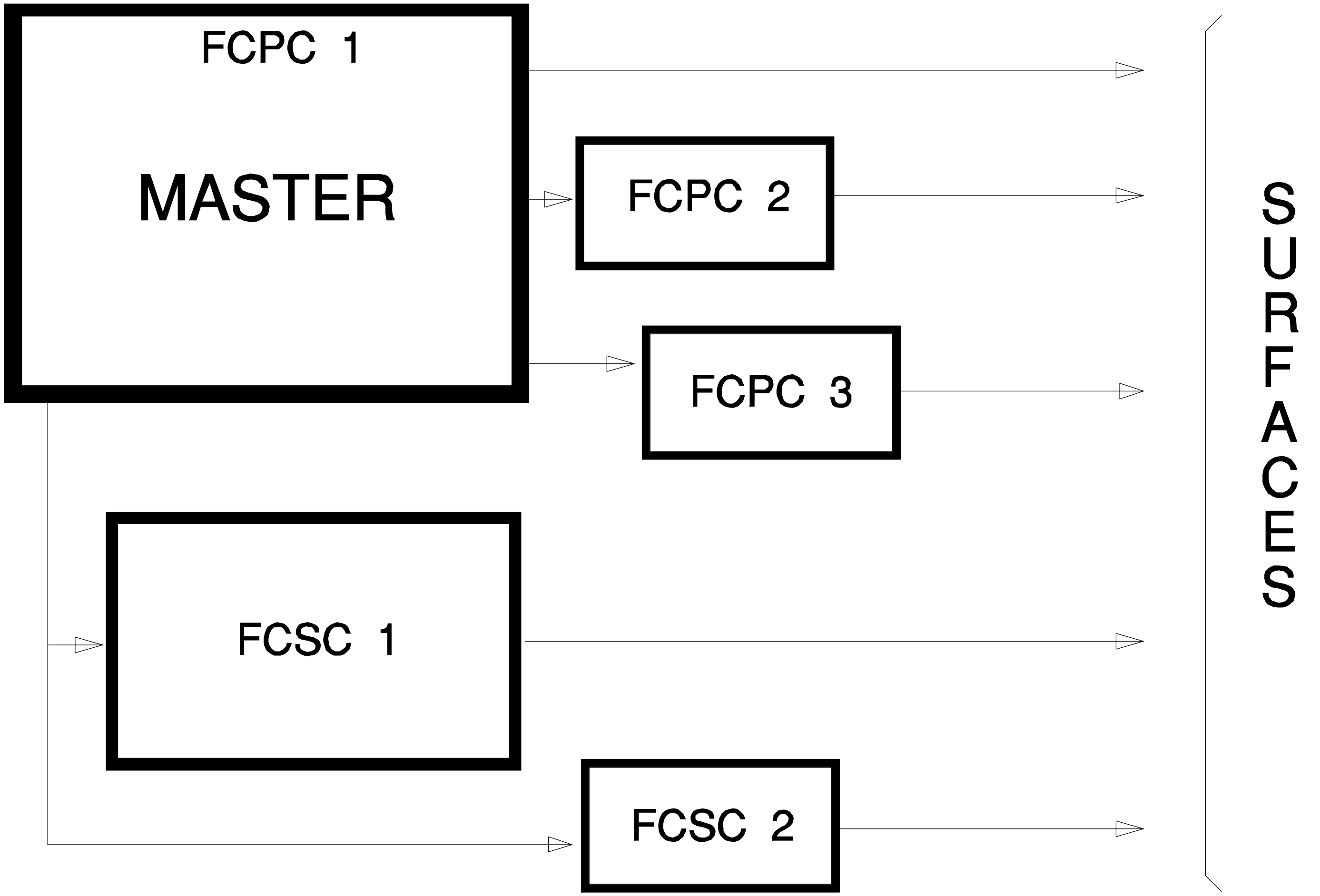
- DATA CONCENTRATION
- WARNINGS
- MAINTENANCE

PHILOSOPHY

One computer is the master for law computation.
All the computers compute the surface deflection orders but they use the orders from the master to control their associated servo controls. FCPC1 is the master for law computation in normal conditions :

- this computer generates the deflection orders and transmits them to the other computers
- the 5 computers ensure the servoloop control according to these orders.

In order to simplify the Law reconfiguration logics, all the laws can be computed by the FCPCs. The normal laws ensure full envelope protection.
The normal laws are degraded in alternate laws with limited protections in case of multiple failures. The direct laws are used on ground or when normal and alternate laws are lost.
The normal laws and the pitch alternate laws are not computed in the FCSCs for simplification reasons. The FCSCs only perform servoloop control in normal conditions and, in case of loss of three FCPCs, the yaw alternate law or the direct laws



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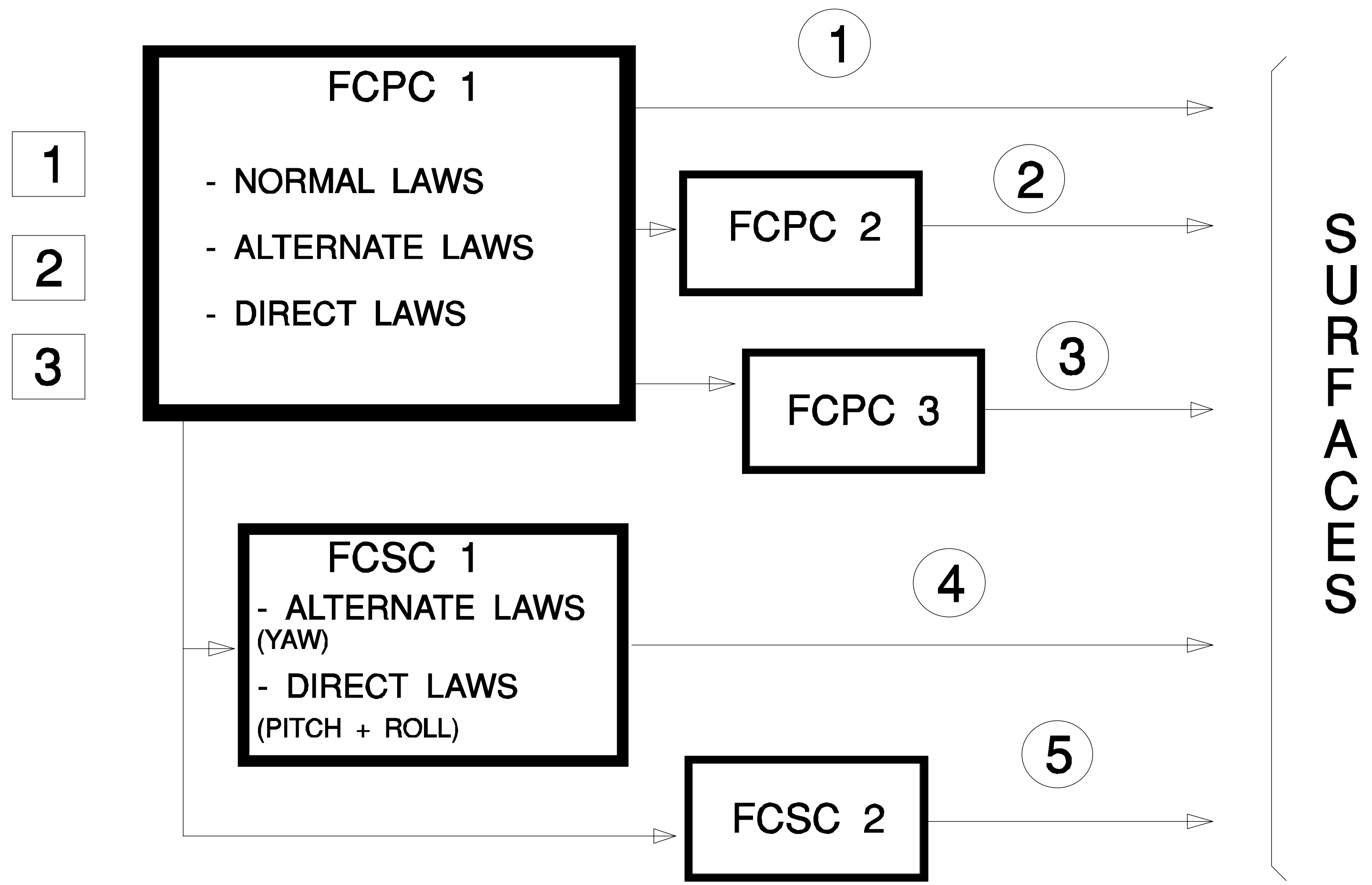
PRIORITY LOGIC FOR LAW ENGAGEMENT

The law engagement logic in the computers takes into account the computer priority order and the control law level.
Each computer establishes the highest level of law that can be engaged, according to its internal monitoring and the availability of ADIRUs, control signals, surface actuation and the positions of the THS, the flaps and the slats.
Among the computers which can engage the highest level of law, the computer having the top priority is chosen.

Note : the priority logic for law engagement is totally independent from the servoloop engagement logic.



1 COMPUTER PRIORITY ORDER

1 LAW PRIORITY ORDER (THE MOST ADVANCED TO THE LEAST ADVANCED)

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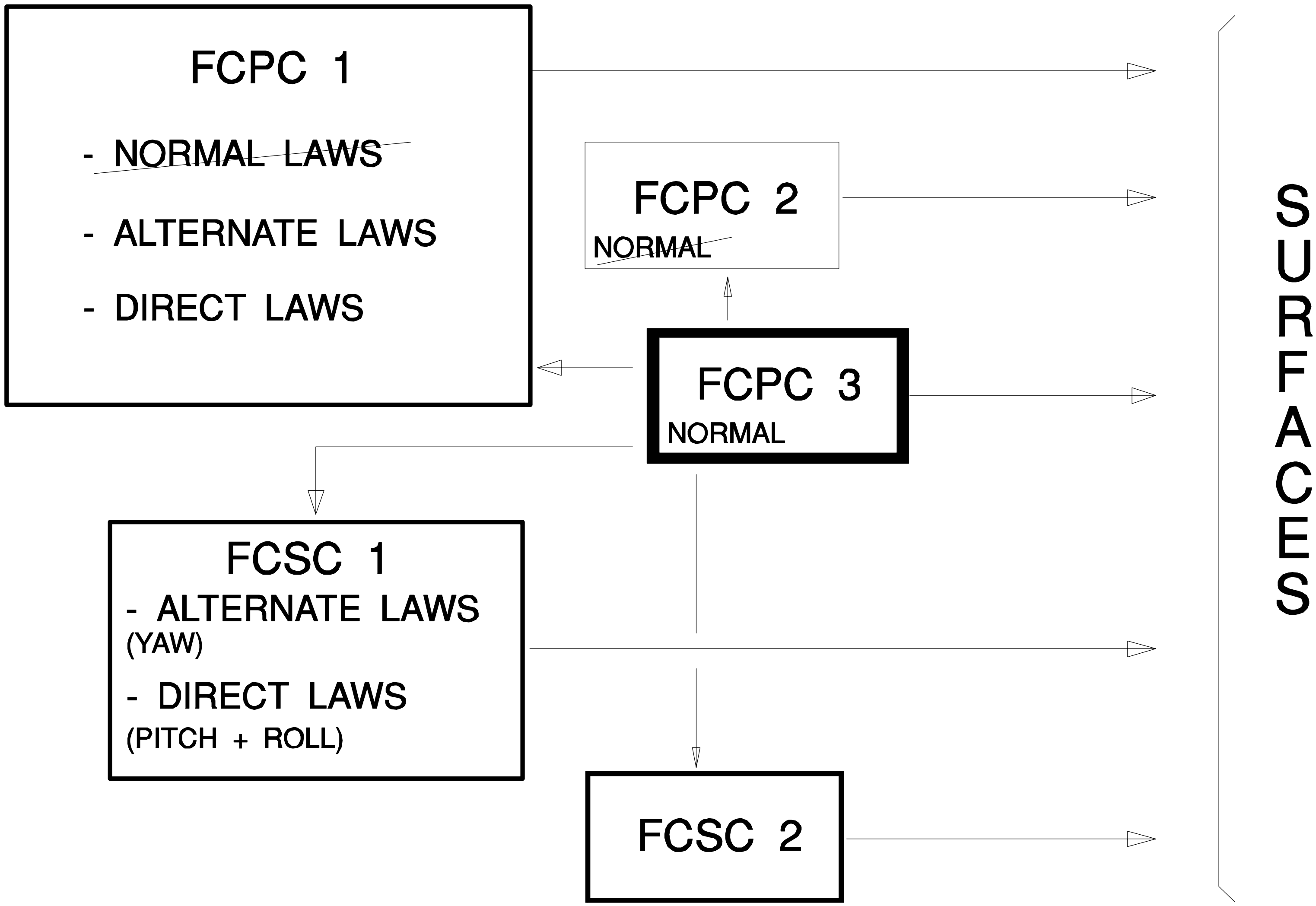
The computer which has the highest level of law, and according to the computer priority, is the master for law computation.

DEGRADED CASE EXAMPLE

- Loss of normal laws in FCPC1 and in FCPC2
- FCPC3 is the only one which can compute the normal laws, it becomes the master for law computation.
- It transmits the deflection orders to all the other computers which ensure their respective servoloop control.



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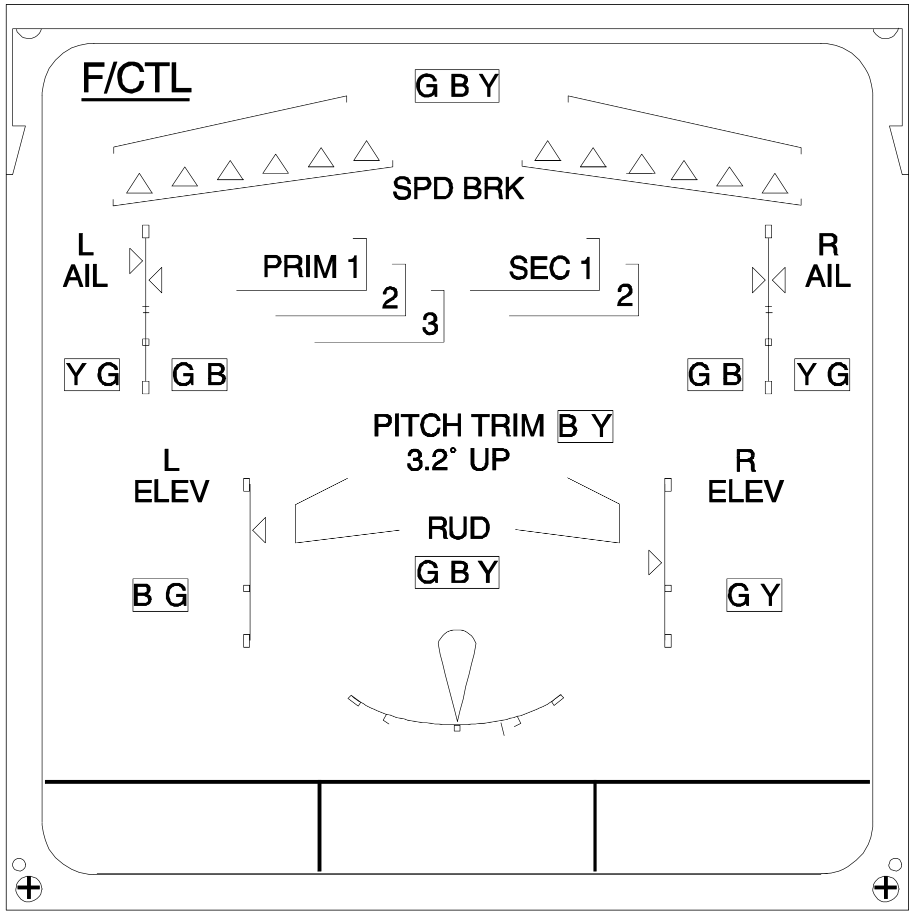
STUDENT NOTES:

ECAM PAGE PRESENTATION

Spoilers
Ailerons
Computers
Pitch Trim
Elevators
Rudder

All indications displayed are fixed and in white colour.



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SPOILERS

The hydraulic system pressure indication is normally green.
Hydraulic system pressure indications :

G B Y Normally displayed in green,

G B Y in amber when the F/CTL computers detect a low pressure in the hydraulic system,

B Y suppressed when the information is not available from FCDC.

Each spoiler indication is green when the surface is operative.

△ In green when the spoiler is normally extended.

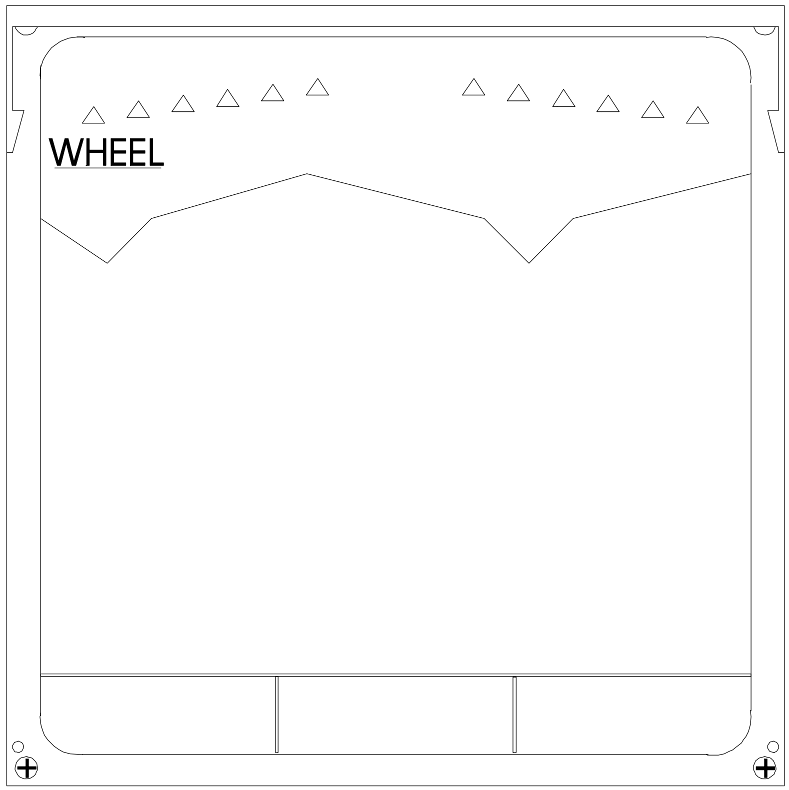
△ In amber, if it is extended with spoiler hydraulic or electric status detected as being faulty.

— In green when the spoiler is normally retracted.

3 In amber if it is retracted and faulty.

X In amber when FCDC does not receive a valid position indication from spoiler, or when status information is not available from FCDC.

The spoiler/speed brake position indications are displayed on the wheel page in order to be monitoring during the approach and landing phases.



The spoiler position indication on the ECAM wheel page is identical to the display on the ECAM flight control page.

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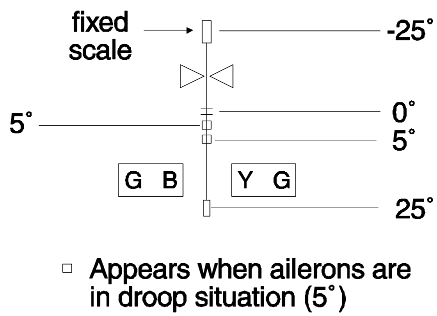
AILERONS

The aileron position is indicated by a green index on the white scale.



The ailerons servocontrol hydraulic power is displayed :

Y G — In green when the hydraulic system pressure is normal.

Y G — In amber when abnormal pressure for a hydraulic system.

Y G — Amber line when an electrical fault is detected on a servocontrol.

The aileron position displays have three states :

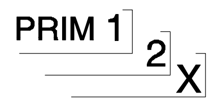
▷ Green.
Actual position of the aileron.
This index can move proportionally to the deviation angle of the actuator (-25°+/-2°, +25°+/-2°).

▷ In amber when the 2 servocontrols have a faulty electrical or hydraulic status.

XX — When the position information is not available from FCDC.

COMPUTERS

The computer number indications are normally green.



Number in green and the box in grey when the computer is healthy.

In amber when the computer is faulty.

Number replaced by an amber X when the computer status information is not available from FCDC.

PITCH TRIM

Pitch trim word is normally white.

PITCH TRIM — In white when conditions are normal or when the information is not available.

PITCH TRIM — In amber when the THS command is jammed.

The hydraulic system pressure indications are identical to those for the spoilers.

The Trimmable Horizontal Stabilizer position is normally green.

3.2° UP — Normally in green. UP when the position is between -16° and -0.05° and DN when the THS position is between 0.05° and 3°.

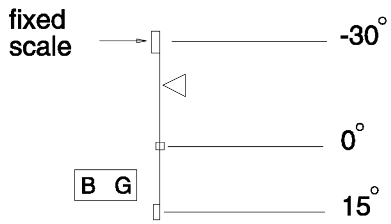
2.2° UP — Nothing is displayed when the position is between -0.05° and 0.05°, or when the position information is not available.

3.2° UP — In amber when both Yellow and Blue hydraulic systems are in low pressure.

XX — When the THS position information is not available from FCDC.

ELEVATORS

The elevator position is indicated by a green index on a white scale.



The hydraulic system pressure indications are the same as the ailerons.

B G In green when hydraulic system pressure is normal.

B G In amber in case of abnormal pressure for a hydraulic system.

B G In green and amber line when an electrical fault is detected on a servo-control.

The elevator position has three states :

▷ Green arrow for the actual position of the elevator.
This index can move proportionally to the deviation angle of the actuator (-30°+/-2°, +15°+/-2°).

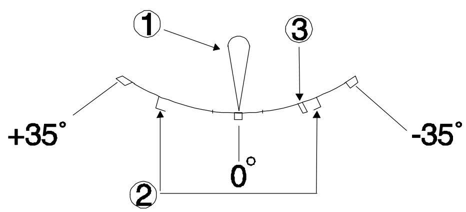
▷ In amber when the 2 servocontrols have a faulty electrical or hydraulic status.

XX When the position information is not available from FCDC.

RUDDER

The rudder position indication is normally green.

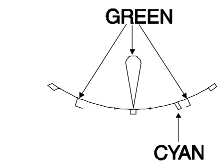
G B Y Hydraulic system pressure indications identical to spoilers.



The rudder, the rudder trim and the rudder travel limitation are displayed on the ECAM page.

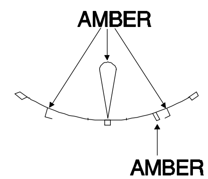
1	Green. Rudder position represented by an index which can rotate proportionally to the deviation of the rudder, in the range ($-35^{\circ\,-4.2^{\circ},\,+2.3^{\circ}}$, $+35^{\circ\,-2.3^{\circ},\,+4.2^{\circ}}$).
2	Green. Two symmetrical indexes represent the rudder travel limits. They can move around the rudder scale proportionally to the TLU (Travel Limitation Unit) position plus 5 degrees to take into account the maximum error that might be generated in the measurement of the TLU and rudder positions.
3	Cyan. Movable index for the rudder trim position, with deviation angles in the range ($-29.2^{\circ\,+/-2.3^{\circ}}$, $+29.2^{\circ\,+/-2.3^{\circ}}$).

In normal conditions, the rudder position and the rudder travel limit indexes are green and the rudder trim position index is cyan.



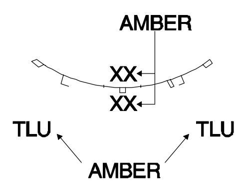
Normal conditions

Upon the FCDC:



- The 3 hydraulic systems are in low pressure.
- The rudder trim command systems are both faulty.
- The TLU command systems are both faulty.

Not available from FCDC:



- Rudder position (replaced by XX).
- Rudder trim position (replaced by XX).
- TLU position: indexes suppressed (replaced by TLU).

PITCH CONTROL PRESENTATION

GENERAL

The pitch control is achieved by the two elevators and the THS via the computers, and controlled by the pitch side sticks orders or autopilot commands.
For the pitch order computation, the FCPCs and the FCSCs need input signals from Air Data Inertial Reference Units (ADIRUs), hydraulic system and back-up accelerometers.

Max elevator deflection: 30° nose up
15° nose down.

Max THS deflection: 14° nose up (THS)
2° nose down.

ELEVATORS

Two electrohydraulic servocontrols actuate each elevator. A transducer unit, mounted adjacent to the servocontrols on each elevator, transmits the surface position information to the computers.
Each servocontrol is connected to two computers : one FCPC and one FCSC which satisfies the reconfiguration priorities.
The elevator servocontrols have three control modes, active, damping and centering.
One servocontrol is in active mode (operates the surface): it' s the priority servocontrol. The other is in damping mode (operated by the surface). The centering mode is used to bring the elevators back to the neutral position in case of loss of the electrical control of both servocontrols.

TRIM HORIZONTAL STABILIZER

The THS is actuated by a ball screw jack and powered by two hydraulic motors linked through a differential.
The ball screw jack has a fail safe design, it consists of a double load path design. Position feedbacks of the ball screw jack and feedbacks of the orders are sent by Rotary Variable Differential Transmitters to the FCPCs.
The hydraulic motor servoloop can be :

* electrically controlled by one of the three electric motors, or
* mechanically controlled by the trim wheels.

Note: the trim wheel control has priority over the electrical control.

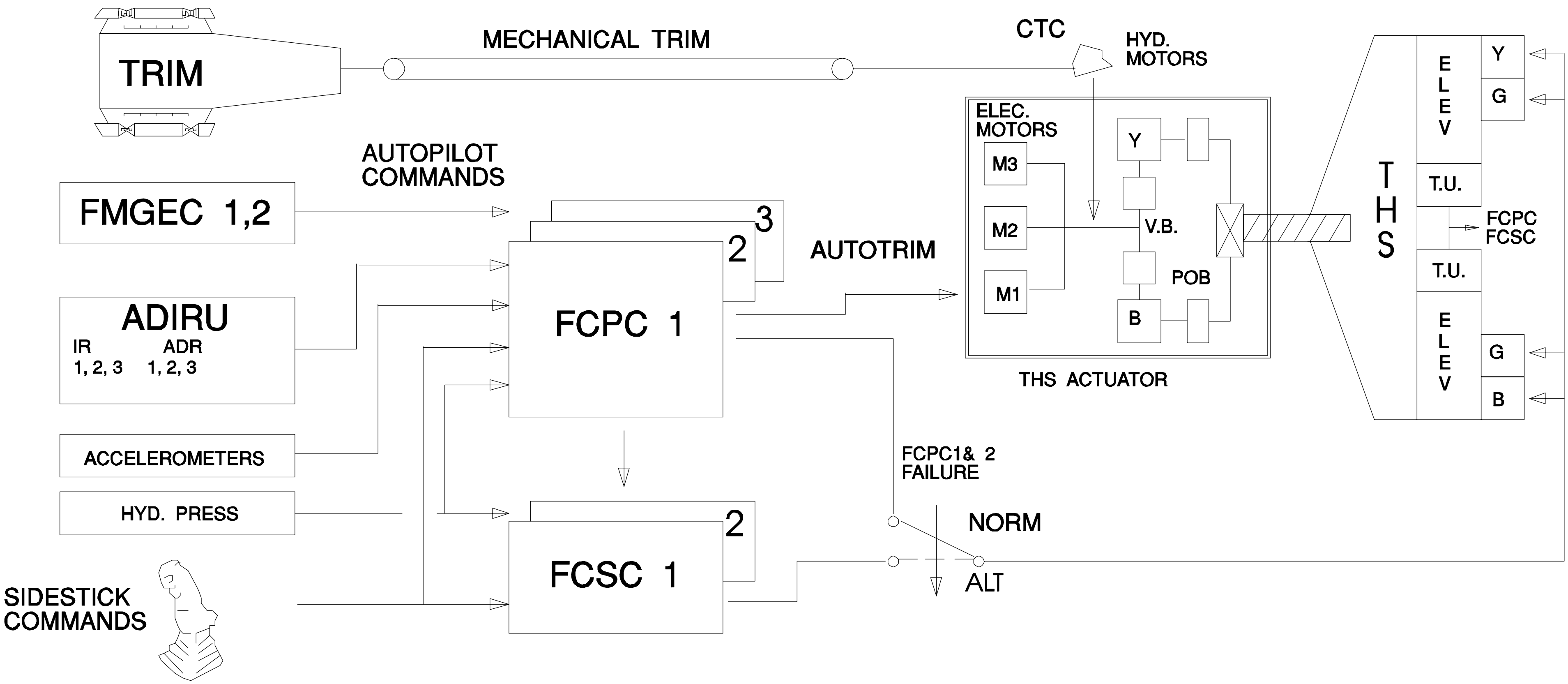
THS MECHANICAL CONTROL

The mechanical pitch trim commmands are achieved by the handwheels in the cockpit and transmitted to the input shaft of the THS actuator.
The THS mechanical control can be used :

- on ground, for take off trim setting.
- in flight, as a standby system if automatic control (autotrim) is not available.

Let's see the following components.

CTC : Cable Tension Compensator
POB : Pressure Off Brakes (locks the hydraulic motor shaft)
VB : Valve Blocks (slide valve).



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STUDENT NOTES:

ROLL CONTROL PRESENTATION

General
Ailerons
Roll Spoilers

GENERAL

The roll control is performed by the ailerons and the roll spoilers via the computers and controlled by the roll side stick orders or autopilot commands. For the roll order computation, the FCPCs and the FCSCs need input signals from Air Data Inertial Reference Units (ADIRUs) and hydraulic systems.

AILERONS

There is one inboard and one outboard aileron on each wing.
Two electrohydraulic servocontrols actuate each aileron.
Each servocontrol is connected to :

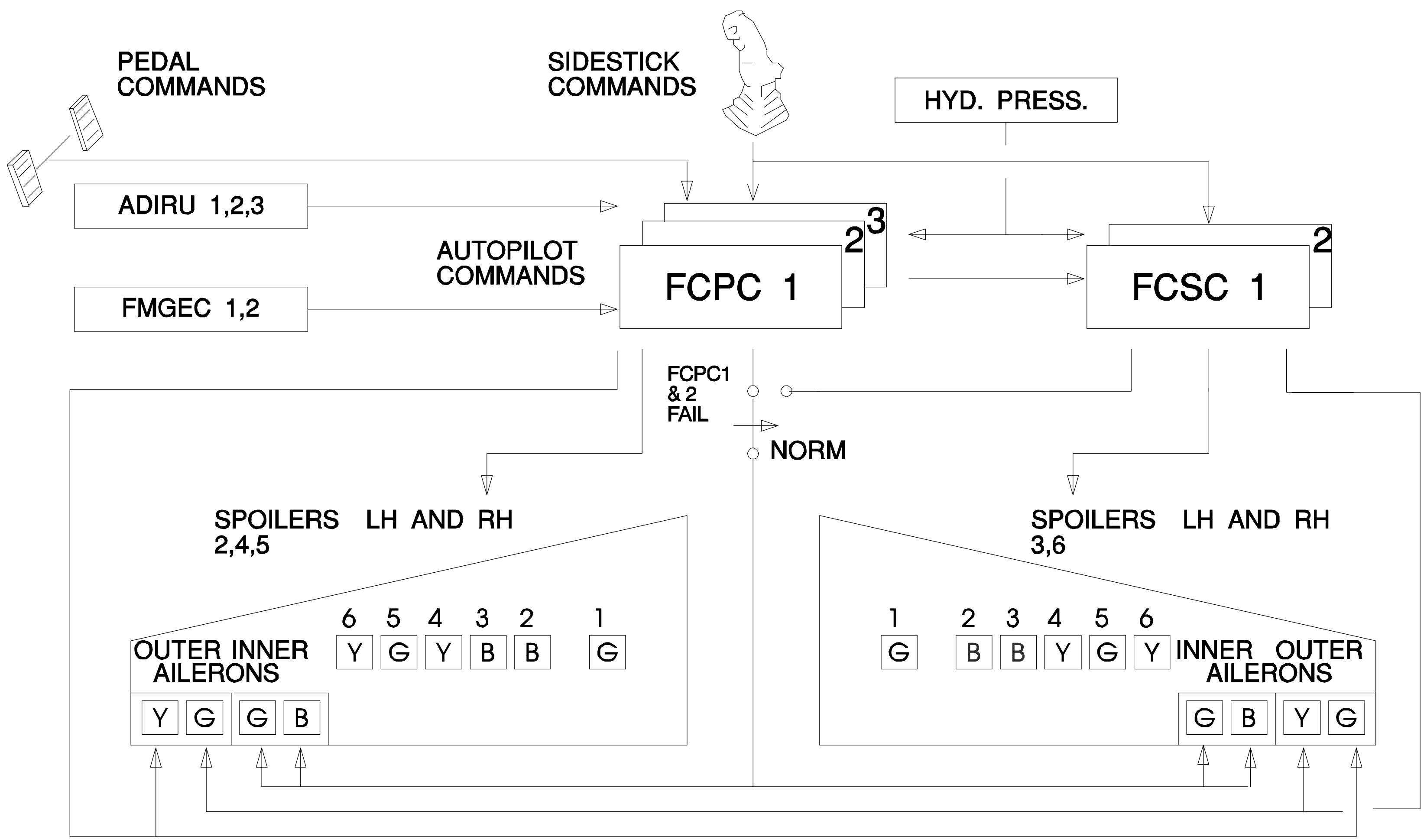
* 2 computers for the inboard aileron (1 FCPC and 1 FCSC)
* 1 computer for the outboard aileron (1 FCPC or 1 FCSC) which satisfies the reconfiguration priorities.

The aileron servocontrols have two control modes, active and damping.
In normal configuration, the outer servocontrol of each aileron is in active mode (priority servocontrol), the inner servocontrol is in damping mode.

Inboard and outboard ailerons are used with same deflections.
At high speed (Vc higher than 190 kts), in clean configuration, the outboard ailerons are servoed to zero.
In AP mode and in certain failure cases, the outboard ailerons are used up to 300 kts.

ROLL SPOILERS

One electrohydraulic servocontrol actuates each spoiler.
Each servocontrol is connected to one computer (1 FCPC or 1 FCSC).
Spoiler 2/3 and 4/5/6 are used with different deflection.



Max aileron deflection : +/- 25°

Max spoiler deflection : 35°

STUDENT NOTES:

YAW CONTROL PRESENTATION

General
Mechanical Input
Rudder Pedal Input
Yaw Damper Input
Rudder Trim Input
Travel Limitation Unit
Back Up Yaw Damper Unit

GENERAL

The yaw control is performed by the rudder. It is controlled by the rudder pedal orders or via the computers, by the autopilot commands, side stick orders, or from the rudder trim control panel.
For the yaw order computation, the FCPCs and the FCSCs need signal inputs from the Air Data Inertial Reference Unit (ADIRUs), the hydraulic system and the back-up gyrometers.
Rudder max deflection : +/- 35°

MECHANICAL INPUT

Three moving body servo controls simultaneously operate the rudder via a common mechanical input.
This mechanical input can receive 3 commands :
* rudder pedal input (mechanical control),
* rudder trim actuator (electrical control),
* yaw damper input (electrical control).

RUDDER PEDAL INPUT

Two sets of rudder pedals, with an individual adjustment device to suit the pilot's morphology, are rigidly interconnected.
These pedals drive the cable linkage through a rod and bellcrank assembly.
An artificial feel unit generates load as a feedback to the pedals for manual control.
Two force laws are generated by the artificial feel unit, one for normal manual control, and another higher one to make the manual override of the autopilot more difficult.
The rod and bellcrank assembly connects the differential mechanism output to the rudder servo controls.
Transducer Units (TU) transmit the position information of the left and right pedals to the FCPCs.

YAW DAMPER INPUT

The two yaw damper servo-actuators form the main electrical inputs of the rudder control.

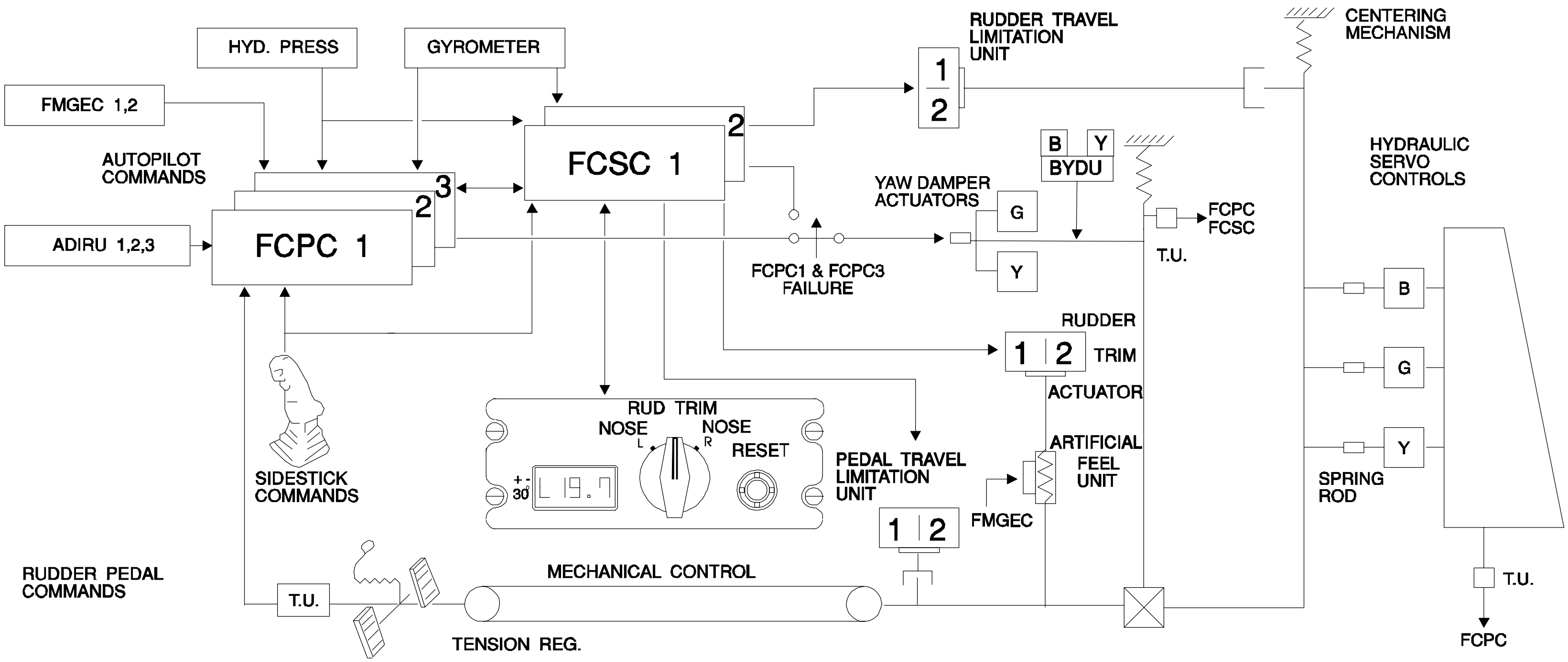
They transmit the rudder deflection orders to the rudder servo control through the differential mechanism.
These are controlled by the lateral control laws which include turn coordination and dutch roll damping in manual or in autopilot mode.
Each yaw damper servo-actuator is connected to 2 computers : 1 FCPC and 1 FCSC.
A Transducer Unit (TU) transmits the yaw damper servo-actuator position to the FCPCs and the FCSCs.

Note : The differential mechanism ensures no mechanical feedback to the rudder pedals.

Only one servo-actuator is active at a time.
One servo-actuator is in active mode (the priority servo-actuator), the other is driven in by-pass mode.

RUDDER TRIM INPUT

The rudder trim actuator controls the rudder position by displacing the zero load position of the artificial feel unit.
In manual control, this actuator is controlled by the pilot command on the rudder trim switch located on the pedestal.
In automatic mode, the commanded deflections are generated by the autopilot.
The rudder trim actuator is controlled by two electric motors, one in active mode, the second in stand by mode.


HYD. PRESS
GYROMETER
FMGEC 1,2
AUTOPILOT COMMANDS
ADIRU 1,2,3
FCPC 1
2
3
FCSC 1
2
RUDDER TRAVEL LIMITATION UNIT
1
2
CENTERING MECHANISM
B
Y
BYDU
YAW DAMPER ACTUATORS
G
Y
FCPC
FCSC
T.U.
HYDRAULIC SERVO CONTROLS
FCPC1 & FCPC3 FAILURE
RUDDER
1
2
TRIM
ACTUATOR
B
G
Y
RUD TRIM
NOSE
NOSE
L
R
RESET
L 19.7
ARTIFICIAL FEEL UNIT
PEDAL TRAVEL LIMITATION UNIT
FMGEC
SPRING ROD
SIDESTICK COMMANDS
RUDDER PEDAL COMMANDS
T.U.
MECHANICAL CONTROL
TENSION REG.
T.U.
FCPC

TRAVEL LIMITATION UNITS

The rudder travel is limited by the Rudder Travel Limitation Unit (RTLU) in function of the aircraft speed to avoid excessive load transmission to the aircraft.
In the same way, the pedal travel is limited by the Pedal Travel Limitation Unit (PTLU).
The two units RTLU and PTLU are identical.
The system is designed in such a way that a single failure will not entail a Travel Limitation Unit (RTLU or PTLU) loss indication.

The RTLU and PTLU are driven by two electric motors controlled by their associated Flight Control Secondary Computers.
The rudder hydraulic servo controls are connected to a centering mechanism which allows the servo control levers to return to a neutral position in case of linkage failure.

BACK UP YAW DAMPER UNIT

The Back up Yaw Damper Unit (BYDU) provides yaw damping in case of total electrical failure.
This function is achieved by an independent unit including its own Blue and/or Yellow hydraulically powered electrical generators.
It computes a yaw damping order similar to lateral alternate law (without turn coordination).

STUDENT NOTES:

STUDENT NOTES

PITCH CONTROL NORMAL DESCRIPTION AND OPERATION

Manual Flight
Autoflight
Autotrim
Laws

MANUAL FLIGHT

The elevators are normally controlled by Flight Control Primary Computer 1 (FCPC1), in which case, the left and right elevators are driven by the green hydraulic servo controls.

The green servo controls are in active mode.
The yellow servo control, for the right side, and the blue servo control, for the left side, are in damping mode.

FCPC1 computes the pitch orders following the normal laws and controls the green elevator servo controls.

Concerning the Trimmable Horizontal Stabilizer (THS), electric motor one controls the two hydraulic motors supplied by the blue and yellow systems. The other two electric motors are in stand-by.

The THS actuator is controlled by FCPC1 through electric motor 1.

AUTOFLIGHT

When the autopilot is engaged, FCPC1 takes into account the AutoPilot (AP) orders transmitted by the Flight Management and Guidance Envelope Computers (FMGECs) and ensures its servoing functions on the elevators and on the THS.

The side sticks are immobilized in neutral position by a solenoid operated load threshold device.
The AP disengagement is requested by the FCPCs when :

- the high Angle Of Attack (AOA) protection or,
- the high speed protection (VMO1) are activated.

AUTOTRIM

In normal configuration, the Autotrim function is automatic, but it can be frozen or limited, in the following cases.

The Autotrim function is frozen :

- when radioaltitude is below 100 ft,
- in high speed protection,
- when the load factor Nz < 0.5 g.

It is limited :

- in high angle of attack protection,
- when Nz > 1.3 g,
- when the bank angle > 33°.

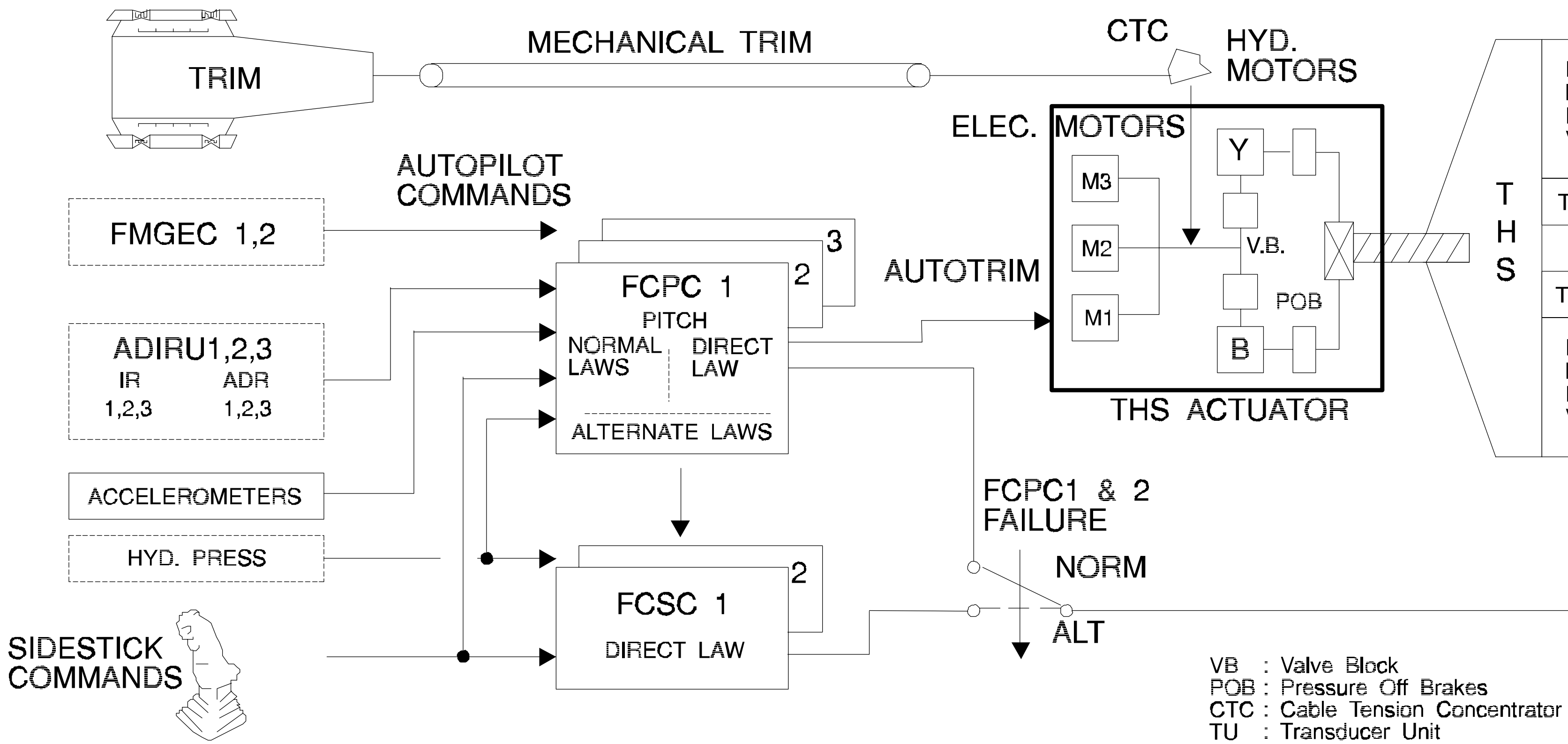
LAWS

In normal configuration, FCPC1 computes the pitch deflection orders with the normal laws in flight, the flare law before touch down and the ground law in roll out or before take-off.

In flight mode, all the protections are effective :

- load factor protection,
- angle of attack protection,
- high speed protection,
- pitch attitude protection.

In flare mode, only the angle of attack protection is effective.



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STUDENT NOTES:

PITCH CONTROL ABNORMAL OPERATION

Computer Failures
Servo Control Failures
Alternate Law With Reduced Protections
Alternate Law Without Protection
Direct Law

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COMPUTER FAILURES

Computer Failures can engage an abnormal configuration.

- In case of loss of FCPC1, FCPC2 performs the pitch control.

FCPC2 :

* Computes the pitch orders in normal laws.
* Controls the blue and yellow elevator servo controls.
* Controls the THS motor 2.

- In case of loss FCPC1 and FCPC2, FCPC3 only performs the autotrim function.

FCPC3 :

* Computes the pitch orders in normal laws.
* Transmits the elevator deflection orders to the FCSC1 which controls the green servo controls.
* Controls the THS motor 3.

- The loss of the three FCPCs leads to loss of pitch normal laws, thus the autotrim function.

FCSC1 :

* Computes the pitch orders in direct laws.
* Controls the green elevators servo controls.

The THS can only be mechanically controlled by the trim wheels.

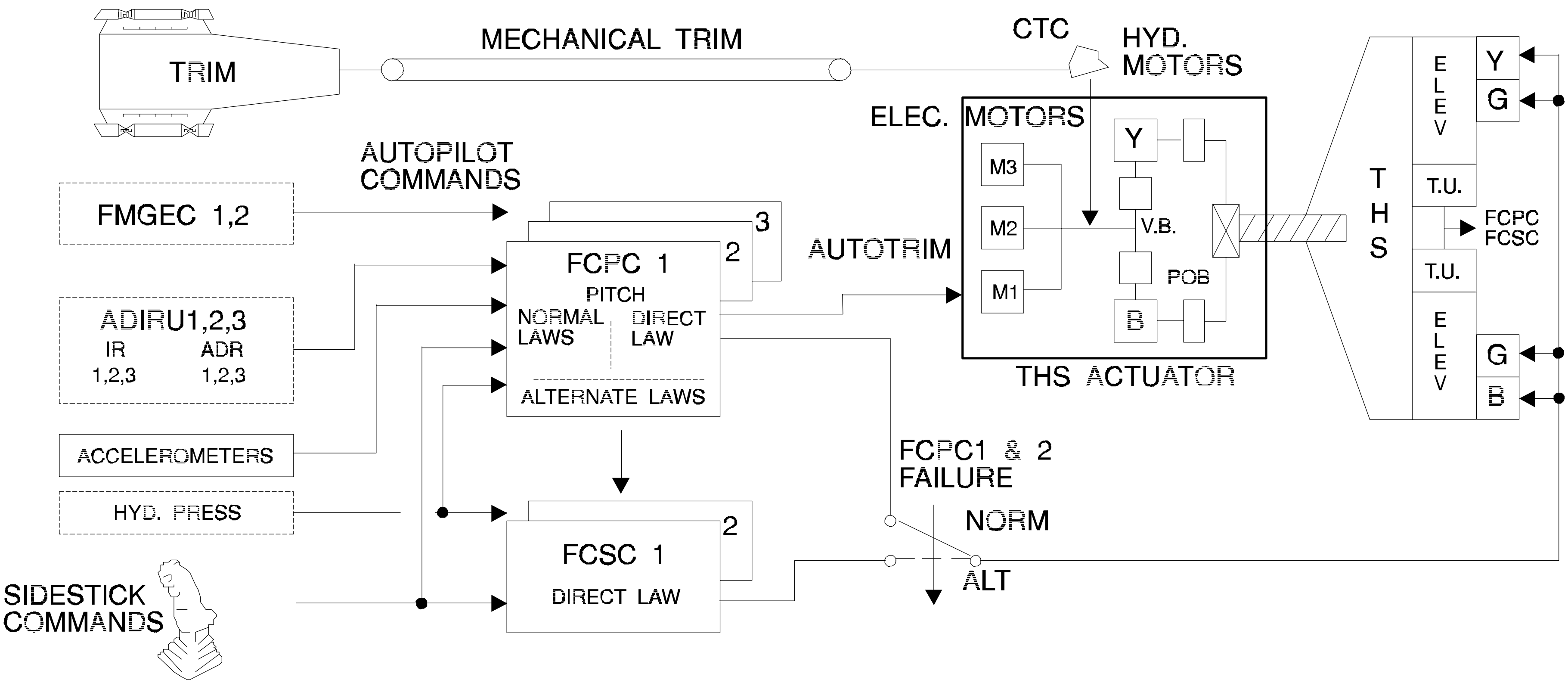
- When all computers are lost :

* The elevators are reset to zero position.
* The longitudinal control of the aircraft is achieved through the trim wheels. (manual pitch trim, mechanical back-up)

SERVO CONTROL FAILURES

The servo control engagement depends on the hydraulic system status, on the monitoring results and on the computer priority order only.

In the event of the loss of one elevator servo control servoing (originating from an electrical or hydraulic failure), the FCPC having the priority is disengaged on the two right and left elevator servo controls and on the THS electric motor that it drives.



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ALTERNATE LAW WITH REDUCED PROTECTIONS

In pitch normal laws, all the protections are available.
In case of loss of surface actuation or of inputs, some protections can be lost.

The pitch alternate laws with reduced protections are activated in the FCPCs in case of loss of :

- THS actuation (B+Y hydraulic circuit or 3 motors lost, ...) or
- 2 Inertial Reference (IR) (second self detected) or 2 Air Data Reference (ADR) or
- All spoilers or all inboard ailerons or
- Slat position or pedal position or
- One elevator (B+G or Y+G hydraulic circuit lost, ...).

In case of loss of slat or flap position or aircraft weight computation, the static stability is also lost.

The angle of attack (AOA) protection is lost and replaced by static stability Vc prot. (see Pitch Laws module).

The pitch attitude (θ) protection is lost.

The high speed protection (VMO1) is lost and replaced by high speed stability VMO2. (see Pitch Laws module).

If a double IR failure occurs, the second being self detected, specific accelerometers are used to consolidate the load factor information and pitch attitude rate information from last IR.

ALTERNATE LAW WITHOUT PROTECTION

In this case, the pitch protections are lost except the load factor protection.

This alternate law without protection is activated in the FCPCs after a triple ADR failure.

DIRECT LAW

In pitch Direct Law, all the pitch protections are lost.
The elevator deflection is proportional to stick deflection.
The autotrim function is lost and only the manual control of the THS is available.

The pitch Direct Law can be activated in the FCPCs or in the FCSCs :

- Momentarily after a double IR failure (second not self detected), or defintively after a triple IR failure.
- After a loss of 3 THS transducers.
- After loss of the 3 FCPCs.
- After loss of the engines.

STUDENT NOTES:

PITCH LAWS

Ground/Flight Logic
Ground Law
Normal Flight Law

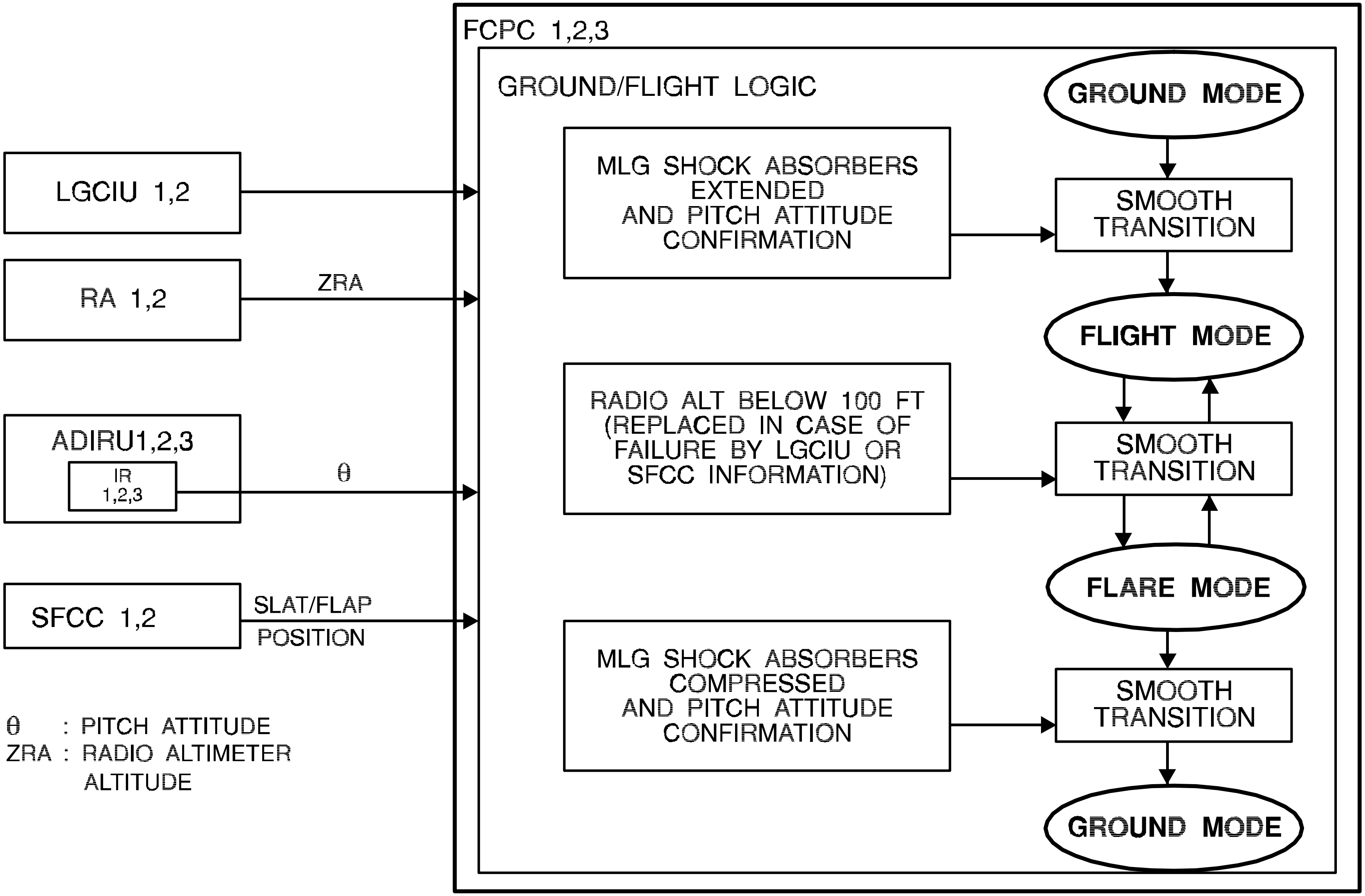
Normal High Angle Of Attack (AOA) Protection
Normal High Speed Protection
Normal Pitch Attitude Protection

Alternate High Angle of Attack Protection
Alternate High Speed Protection

Direct Flight Law
Flare Law
Abnormal Attitude Law
Alpha Floor Detection
Aileron Droop Function
Maneuver Load Alleviation (MLA)

GROUND/FLIGHT LOGIC

The Ground/Flight Logic is achieved by the Flight Control Primary Computers (FCPCs) and determines the different conditions for the transitions between the ground, flight and flare modes.
The corresponding laws are engaged for each mode.



θ : PITCH ATTITUDE
ZRA : RADIO ALTIMETER ALTITUDE

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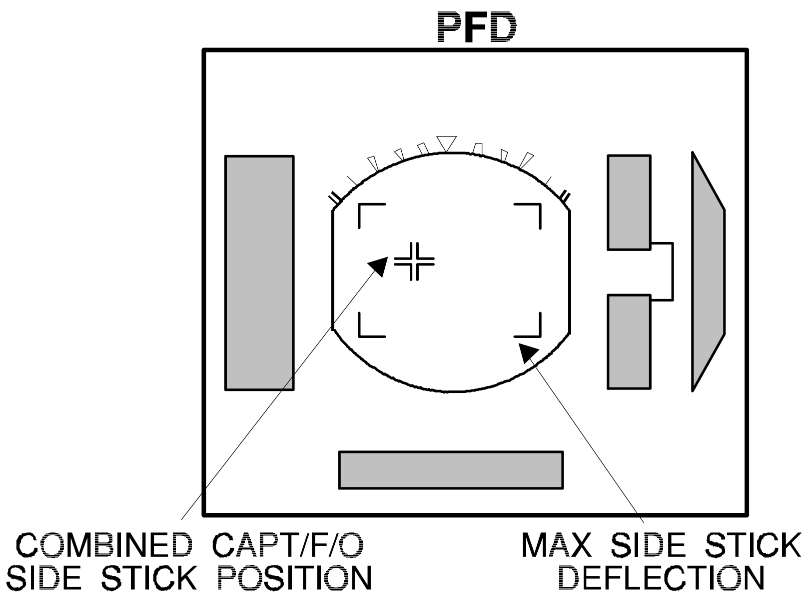
GROUND LAW

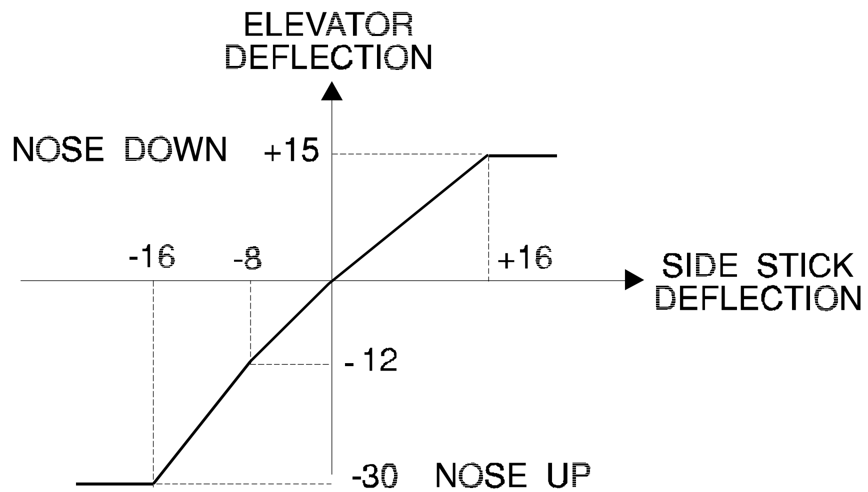
This Law is engaged during the ground mode.
It is computed in the FCPCs and in the FCSCs.

This Law is such that the pilot has maximum authority over the elevators.

A pitch order on the side stick, directly controls a proportional elevator deflection.

The Trimmable Horizontal Stabilizer (THS) control is performed from trim wheels by means of a mechanical linkage.

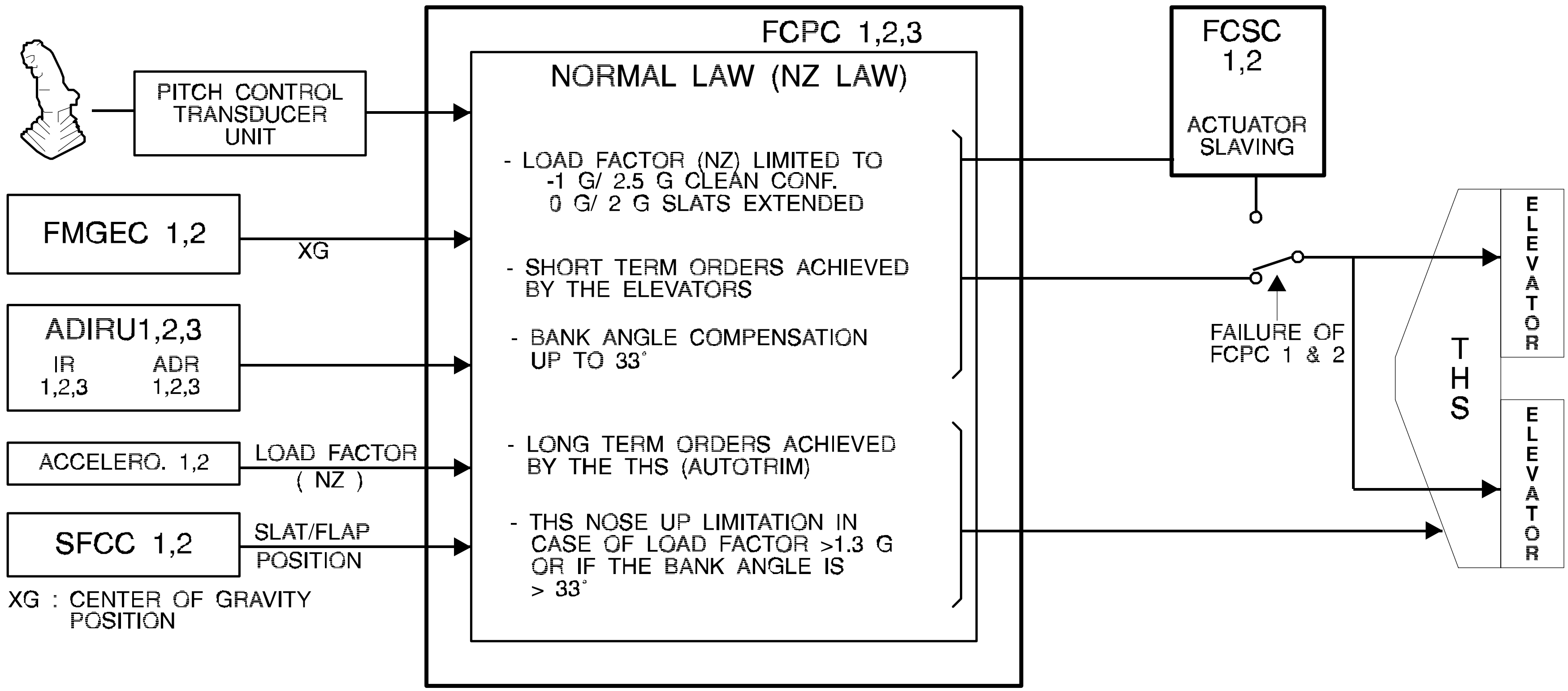

PFD
COMBINED CAPT/F/O
SIDE STICK POSITION
MAX SIDE STICK
DEFLECTION


ELEVATOR
DEFLECTION
NOSE DOWN
+15
-16
-8
+16
SIDE STICK
DEFLECTION
- 12
-30
NOSE UP

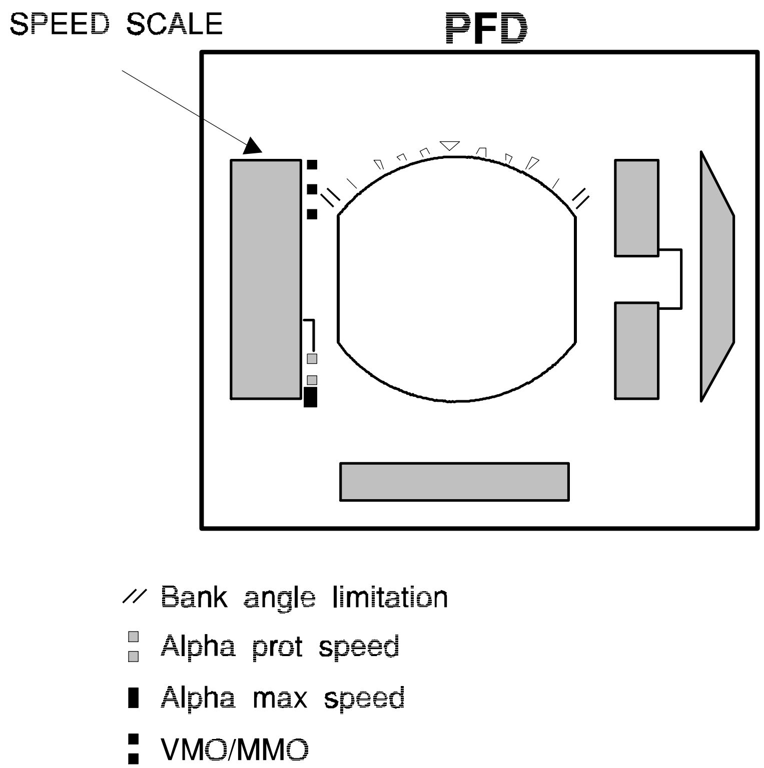
NORMAL FLIGHT LAW

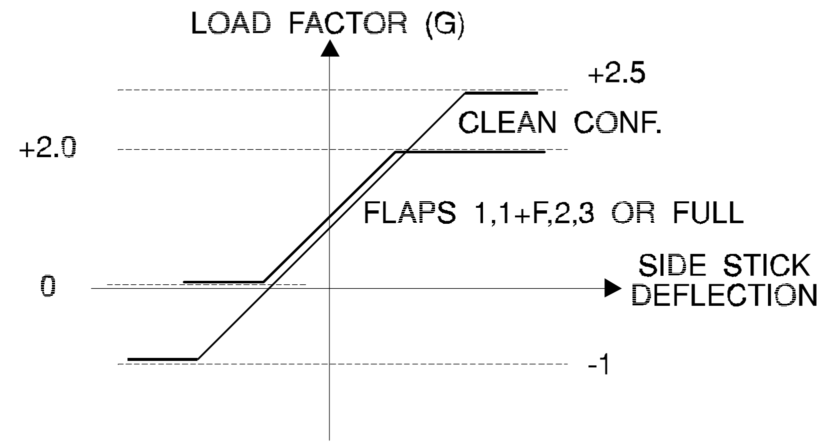
The pitch Normal Law, called Nz law, is the basic law for the pitch control.

In normal conditions, this law is engaged in flight mode with the normal protections.


PITCH CONTROL TRANSDUCER UNIT
FMGEC 1,2
XG
ADIRU1,2,3
IR 1,2,3
ADR 1,2,3
ACCELERO. 1,2
LOAD FACTOR (NZ)
SFCC 1,2
SLAT/FLAP POSITION
XG : CENTER OF GRAVITY POSITION
FCPC 1,2,3
NORMAL LAW (NZ LAW)
- LOAD FACTOR (NZ) LIMITED TO -1 G/ 2.5 G CLEAN CONF. 0 G/ 2 G SLATS EXTENDED
- SHORT TERM ORDERS ACHIEVED BY THE ELEVATORS
- BANK ANGLE COMPENSATION UP TO 33°
- LONG TERM ORDERS ACHIEVED BY THE THS (AUTOTRIM)
- THS NOSE UP LIMITATION IN CASE OF LOAD FACTOR >1.3 G OR IF THE BANK ANGLE IS > 33°
FCSC 1,2
ACTUATOR SLAVING
FAILURE OF FCPC 1 & 2
THS
ELEVATOR
ELEVATOR

INDICATIONS & SCHEMATICS





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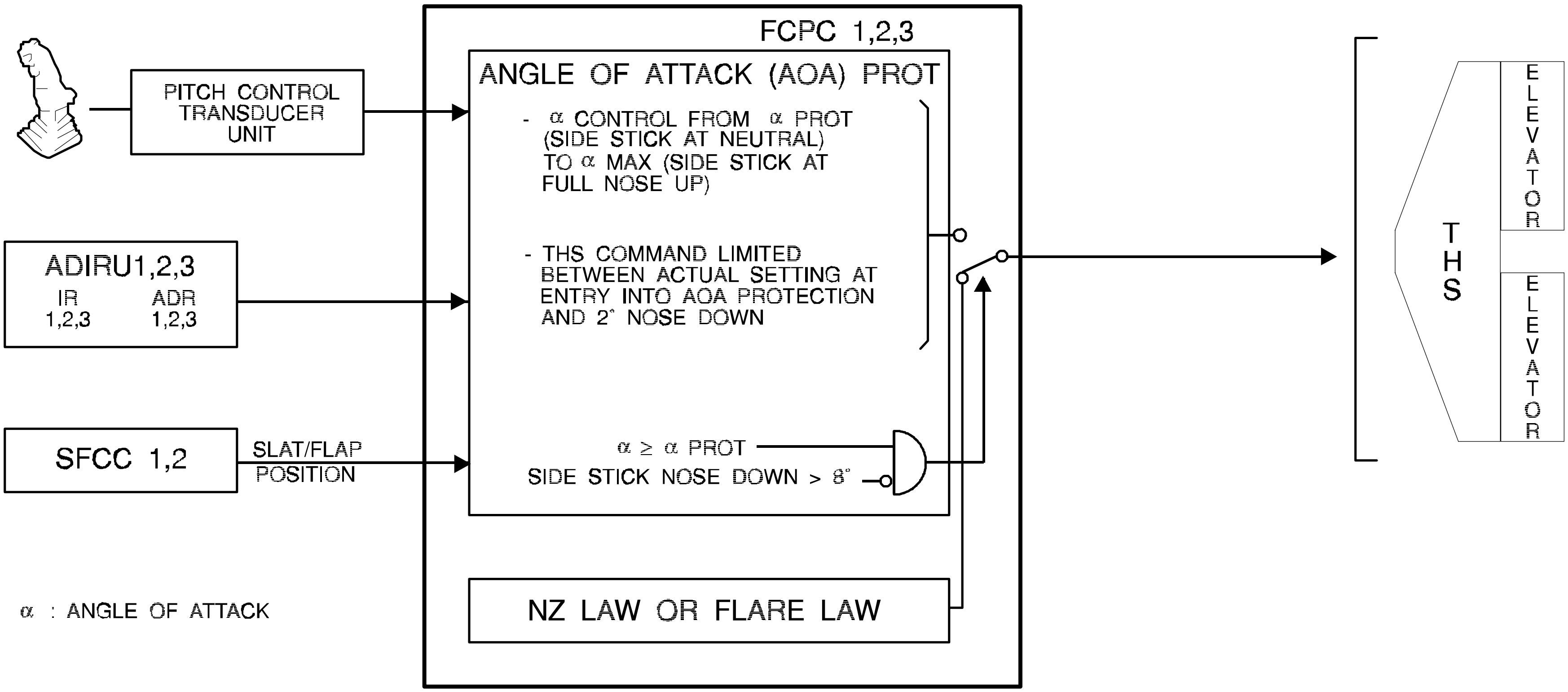
NORMAL HIGH ANGLE OF ATTACK PROTECTION

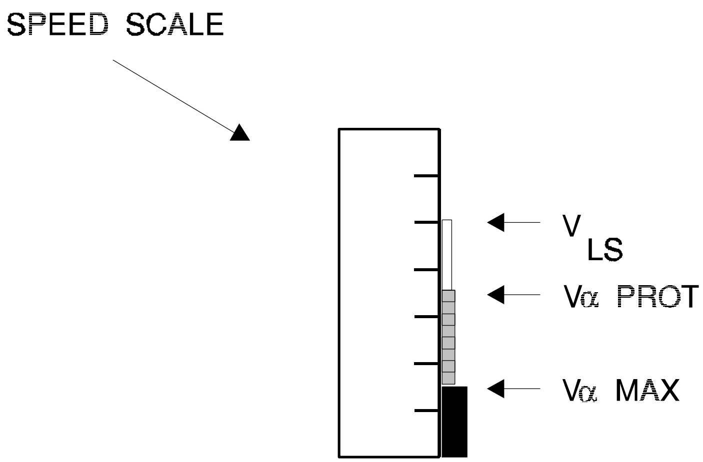
The High Angle Of Attack protection (AOA protection) replaces the Nz law in flight mode or the flare law in flare mode, when the angle of attack alpha is greater than the protection angle of attack called alpha prot.

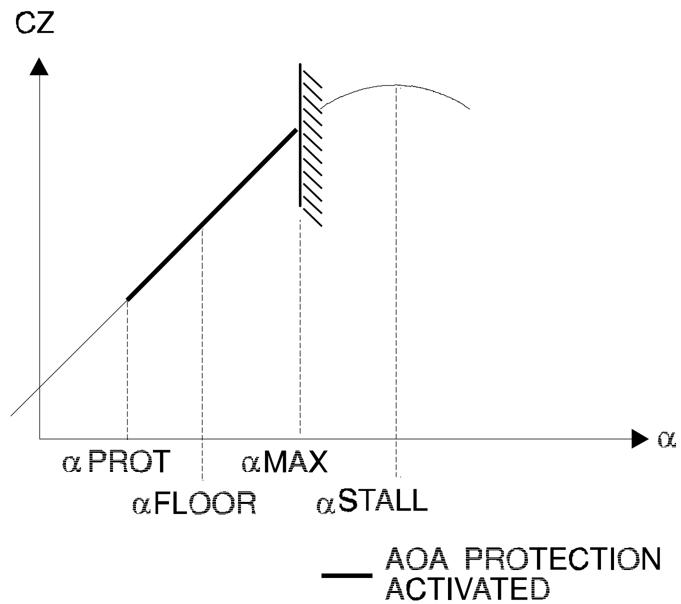
Alpha prot. and alpha max. are thresholds computed in function of aircraft configuration.

In normal conditions, the AOA protection can be engaged in flight or in flare mode.


PITCH CONTROL TRANSDUCER UNIT
ADIRU1,2,3
IR 1,2,3
ADR 1,2,3
SFCC 1,2
SLAT/FLAP POSITION
FCPC 1,2,3
ANGLE OF ATTACK (AOA) PROT
- α CONTROL FROM α PROT (SIDE STICK AT NEUTRAL) TO α MAX (SIDE STICK AT FULL NOSE UP)
- THS COMMAND LIMITED BETWEEN ACTUAL SETTING AT ENTRY INTO AOA PROTECTION AND 2° NOSE DOWN
α ≥ α PROT
SIDE STICK NOSE DOWN > 8°
NZ LAW OR FLARE LAW
THS
ELEVATOR
ELEVATOR
α : ANGLE OF ATTACK

INDICATIONS & SCHEMATICS





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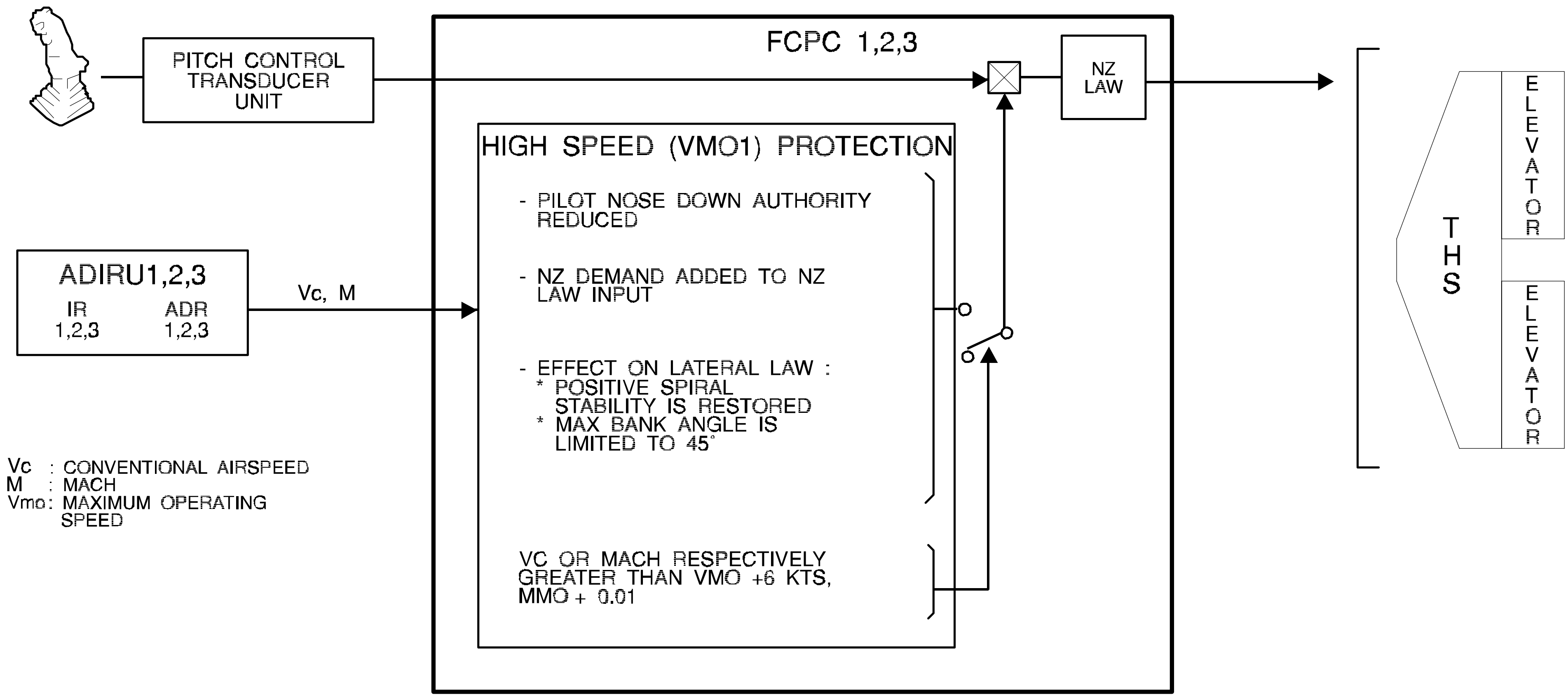
NORMAL HIGH SPEED PROTECTION

The High Speed protection (VMO1 prot) adds a positive load factor to the pilot's orders when the aircraft speed exceeds a certain threshold.

In normal conditions, the High Speed protection can be engaged in flight mode only.



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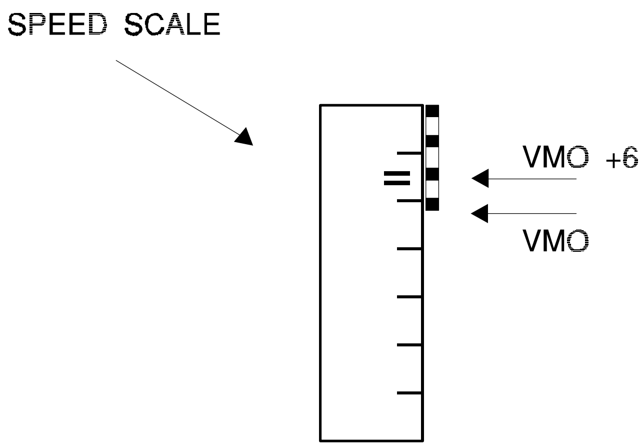
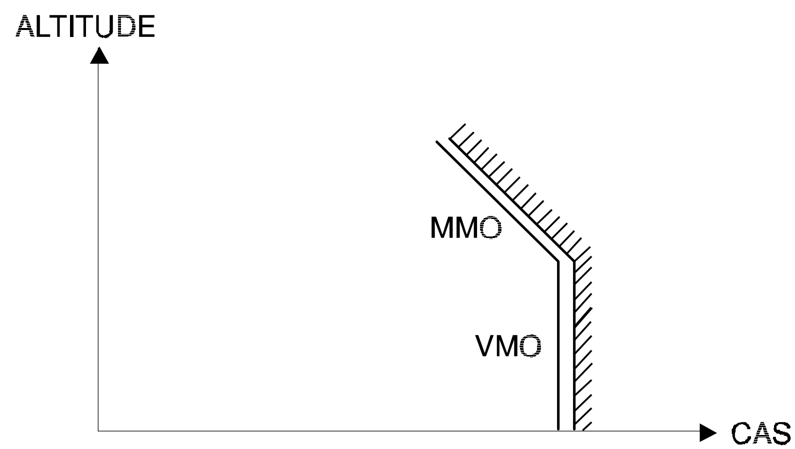
INDICATIONS & SCHEMATICS



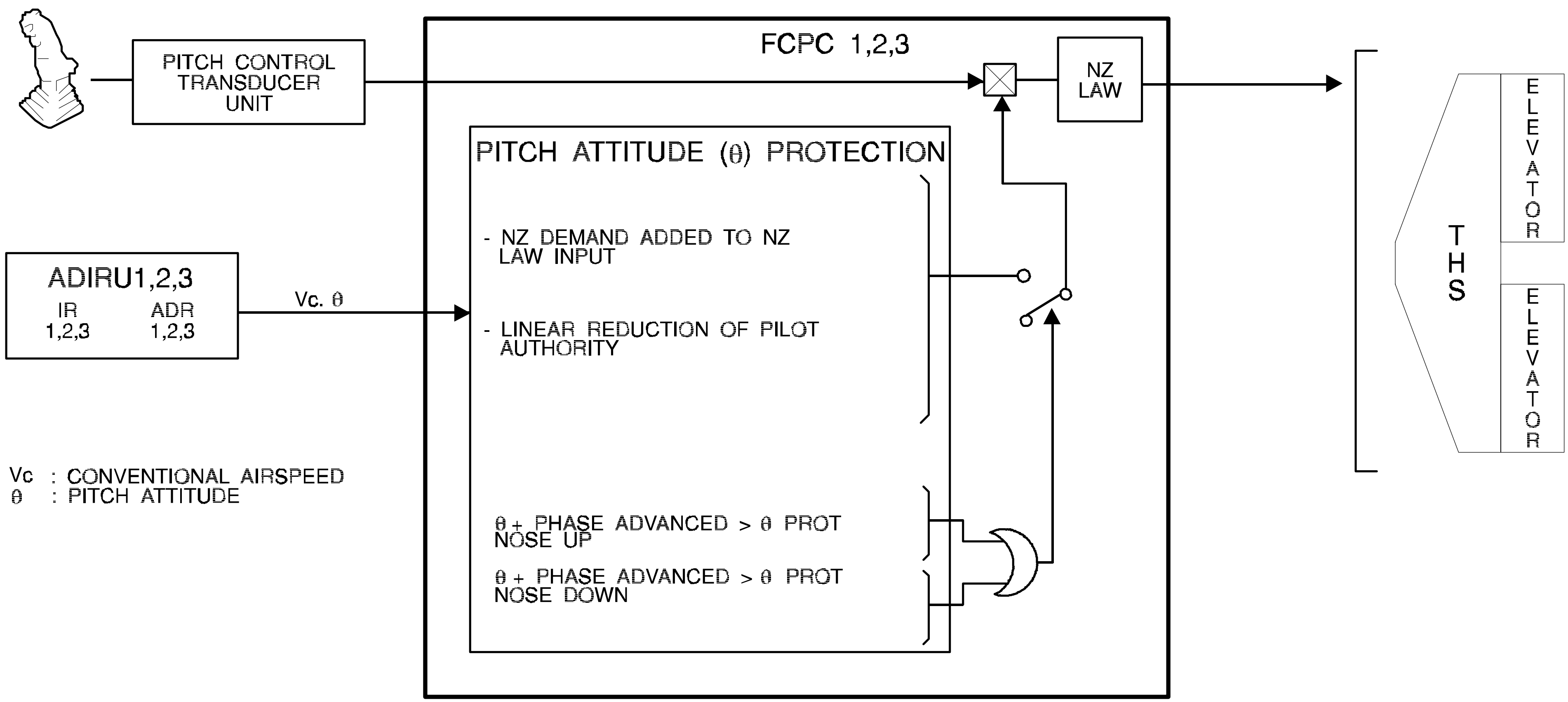


= High speed limitation (VMO + 6 kts)

High speed limitation

NORMAL PITCH ATTITUDE PROTECTION

The Pitch Attitude protection serves to reduce the pilot's authority when the aircraft Pitch Attitude exceeds a threshold.



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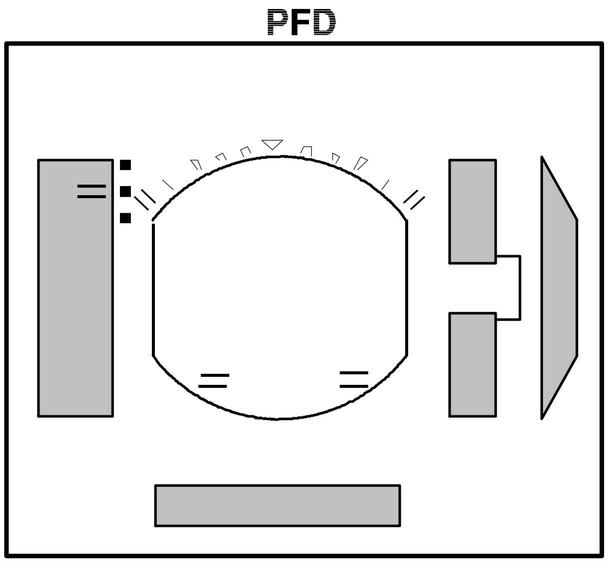
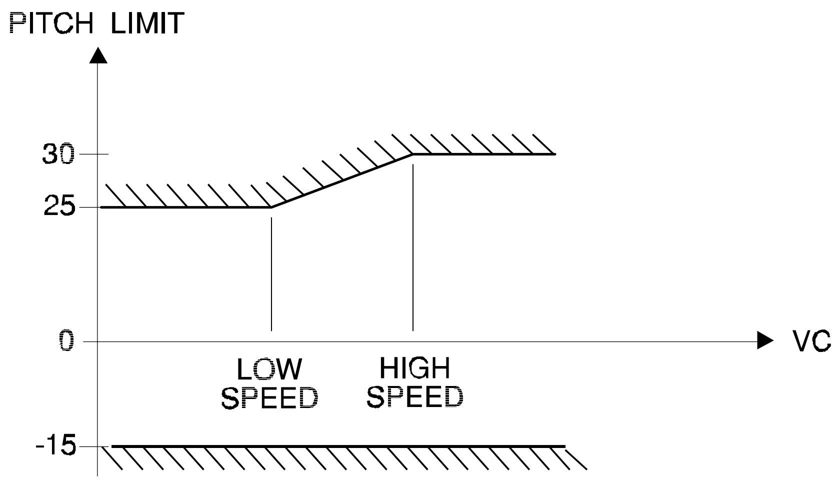
INDICATIONS & SCHEMATICS





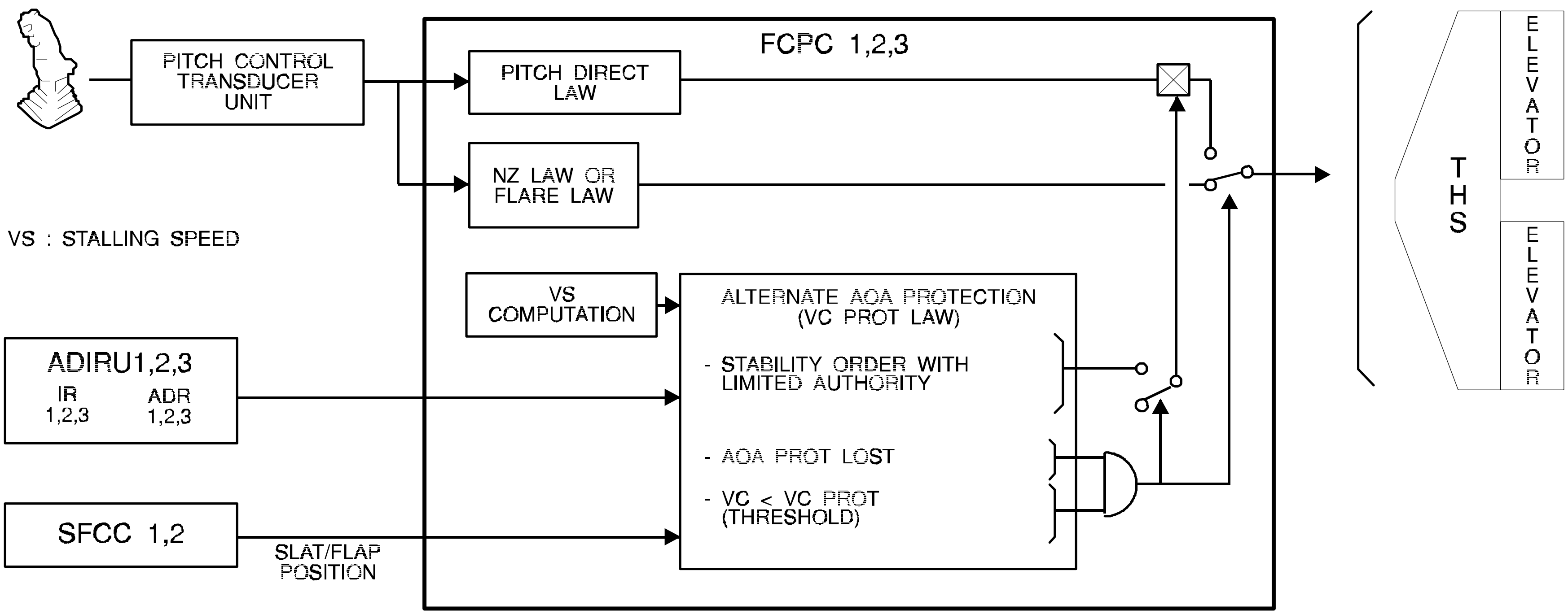
= = Pitch attitude limitation (-15° or 30°)

ALTERNATE HIGH ANGLE OF ATTACK PROTECTION

This Law is engaged in the event of loss of the AOA protection. It's called Vc prot law.

A pitch order on the side stick then directly commands an elevator deflection order to which a stability order with limited authority is added.

The Vc prot law can be engaged in flight or in flare mode.



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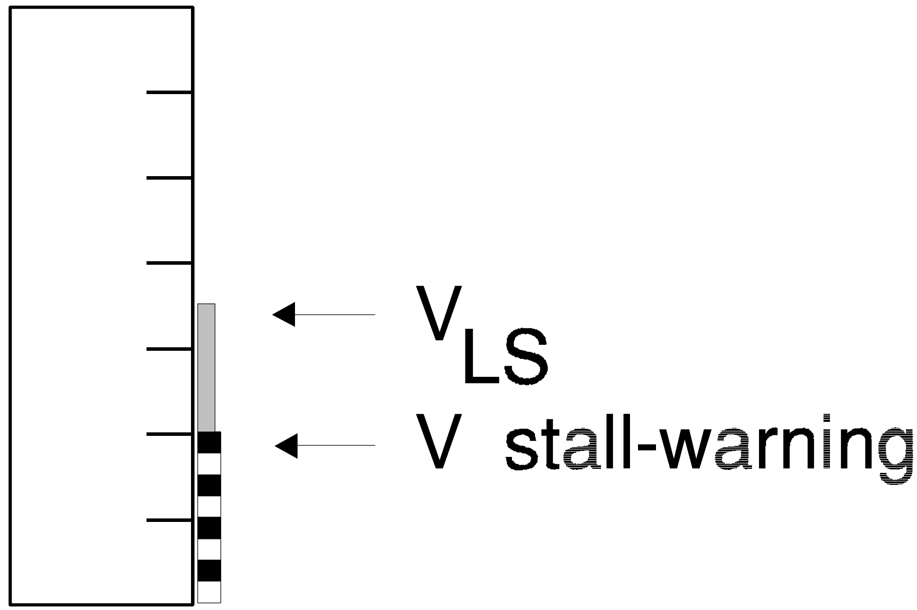
INDICATIONS & SCHEMATICS



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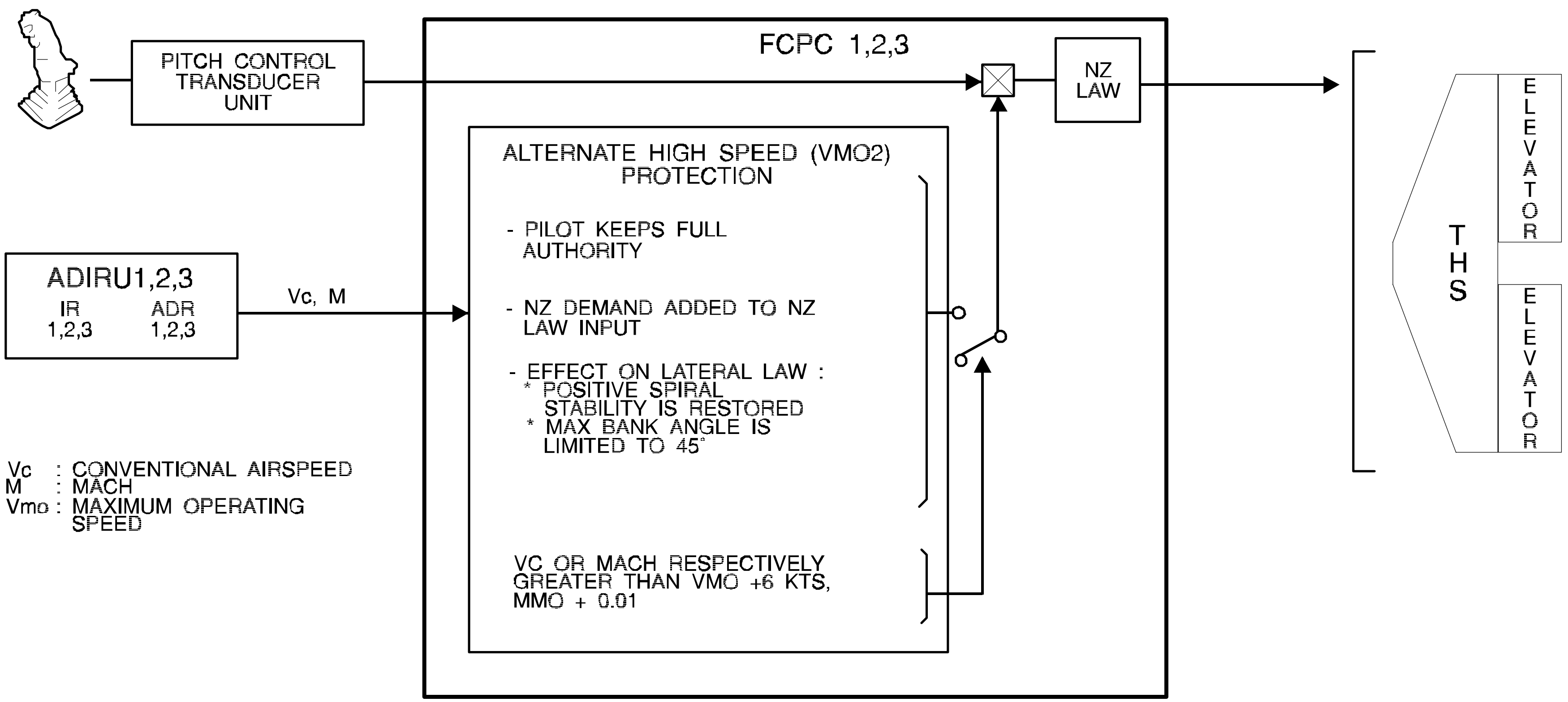
ALTERNATE HIGH SPEED PROTECTION

The Alternate High Speed protection is activated in case of loss of Normal High Speed protection.
It's called VMO2 law.

VMO2 law is identical to VMO1 law except that pilot's authority is not reduced, the pilot keeps full authority.
As for the VMO1 law, the autotrim function is inhibited.



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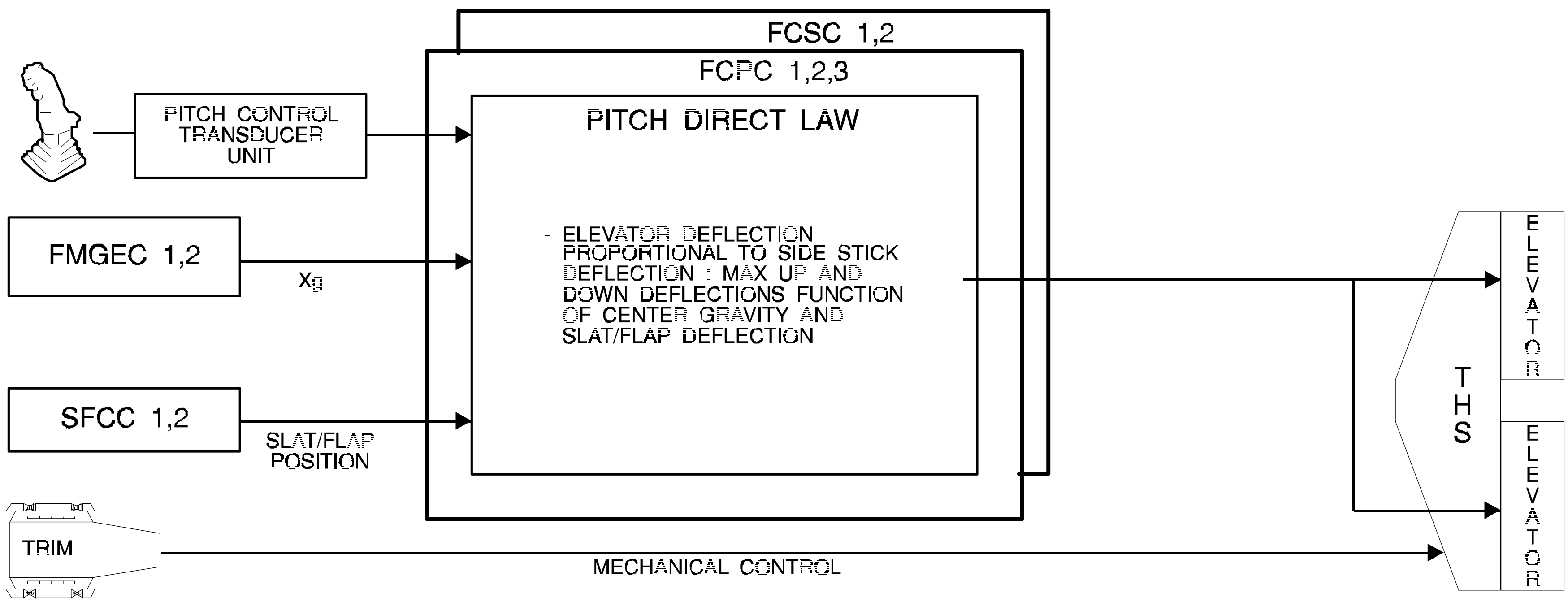
DIRECT FLIGHT LAW

This Law is engaged upon loss of pitch normal law (Nz law).
A pitch order on the stick directly controls a proportional elevator deflection.

THS control is performed through the trim wheels.

The pitch Direct Law is engaged in place of Nz law in flight mode and in place of flare law in flare mode.



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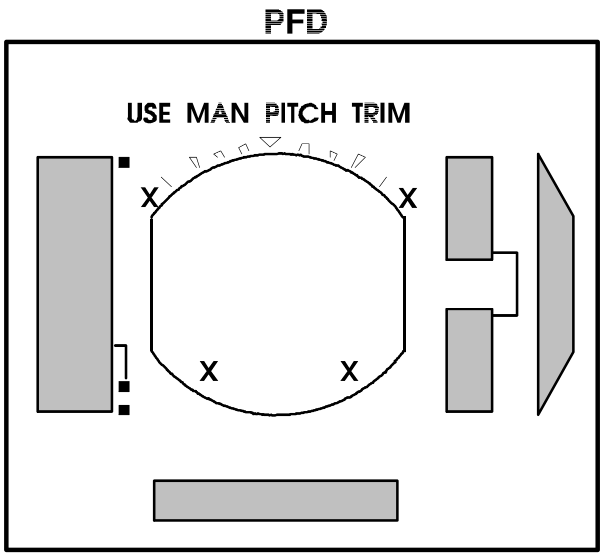
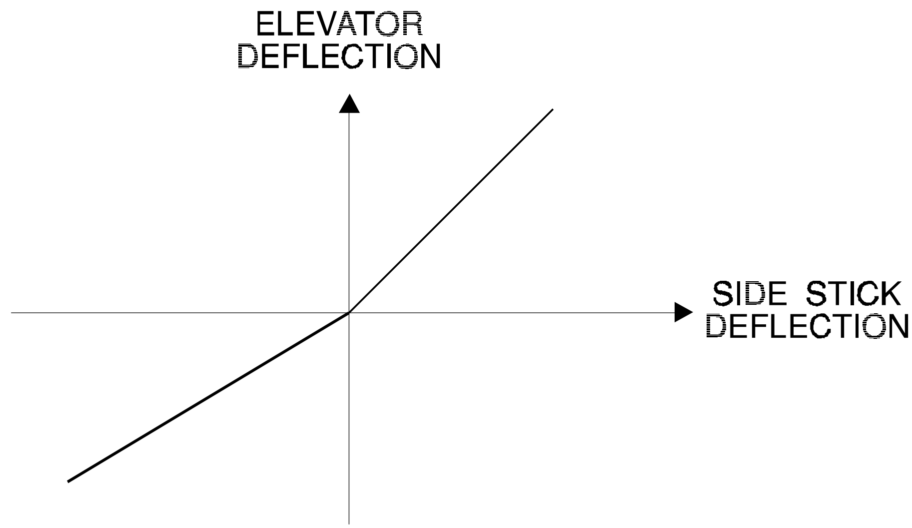
INDICATIONS & SCHEMATICS



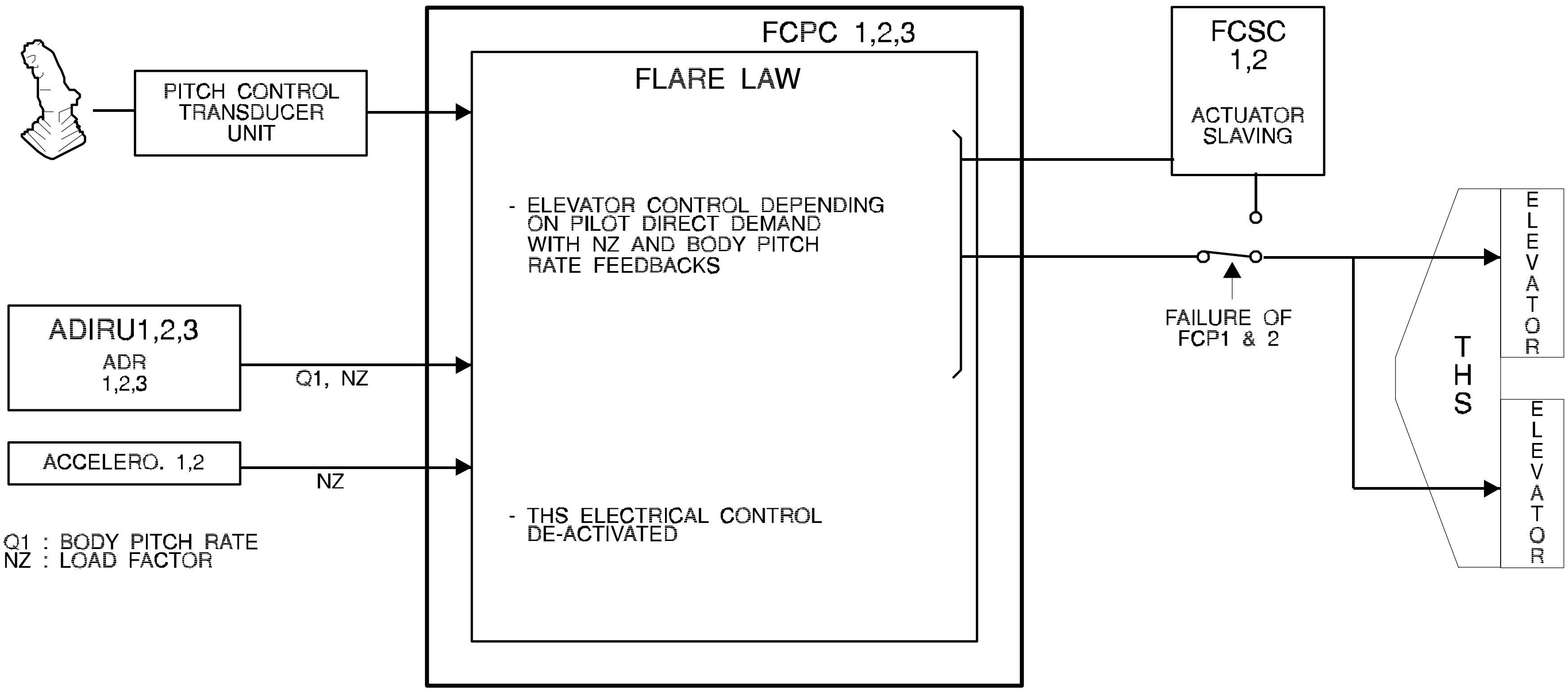


USE MAN PITCH TRIM	replaced by **'MAN PITCH TRIM ONLY'** when in pitch mechanical back-up.
X X	pitch attitude and bank angle limitation are no longer available.

FQW4200 GE Metric

FLARE LAW

This Law is engaged at landing during the Flare mode.
The purpose of this law is to recover a conventional behaviour of aircraft at landing.
Therefore, a gentle positive pilot order is required to flare the aircraft.



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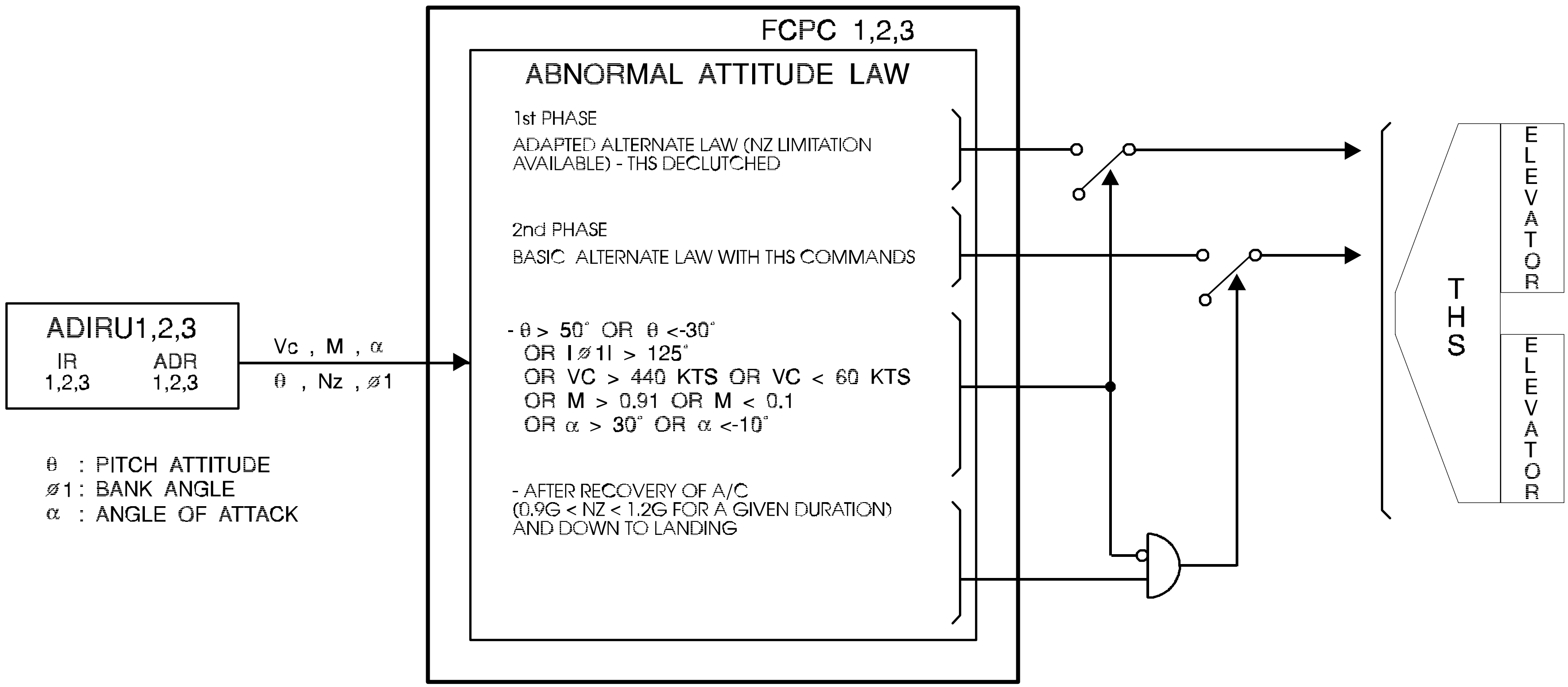
ABNORMAL ATTITUDE

This Law is engaged when certain aicraft flight parameters exceed pre-determined values.



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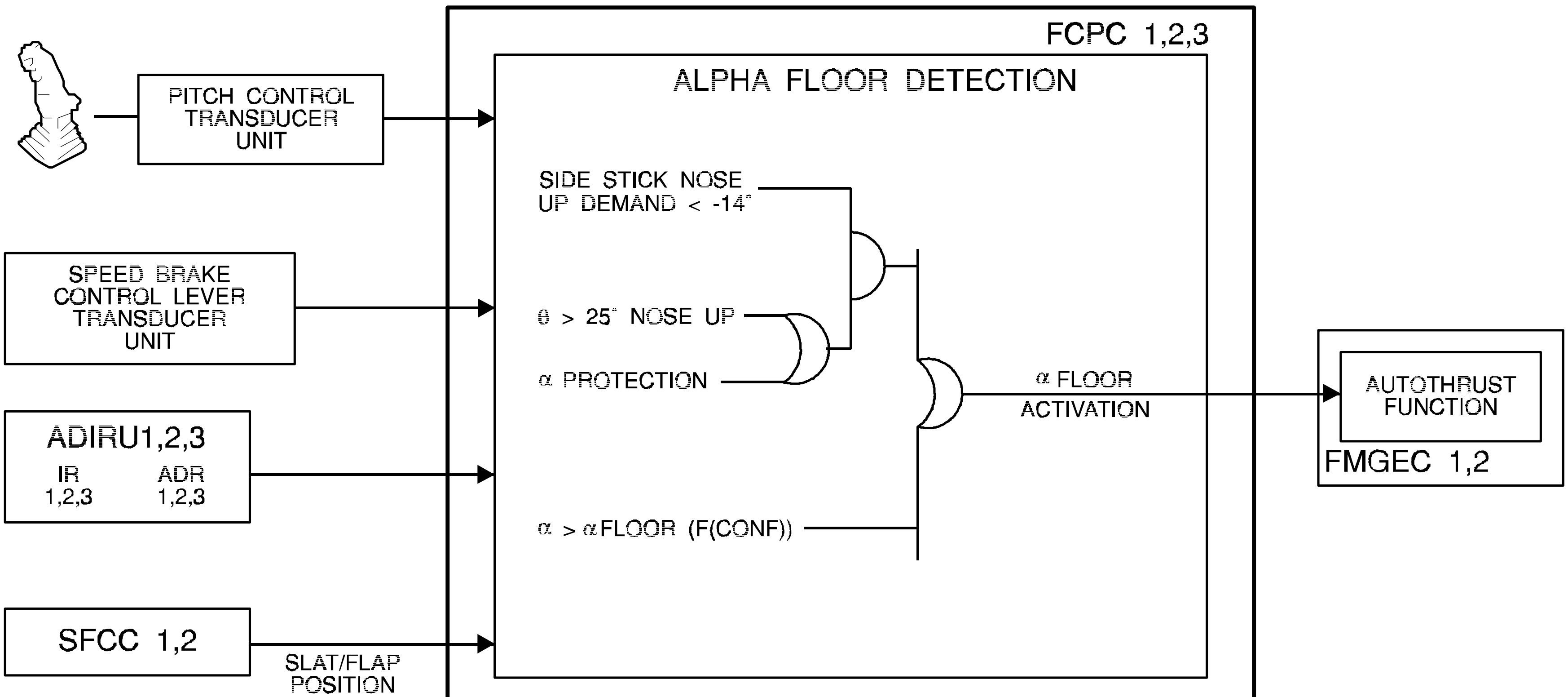
ALPHA FLOOR DETECTION

This Law is such that the pilot has maximum authority over the elevators.
A pitch order on the side stick, directly controls a proportional elevator deflection.
The THS control is performed from trim wheels by mechanical linkage.

When the Alpha Floor Detection is performed, the FCPCs send a signal to the autothrust function which controls the take-off/go around engine thrust whatever the throttle lever position.



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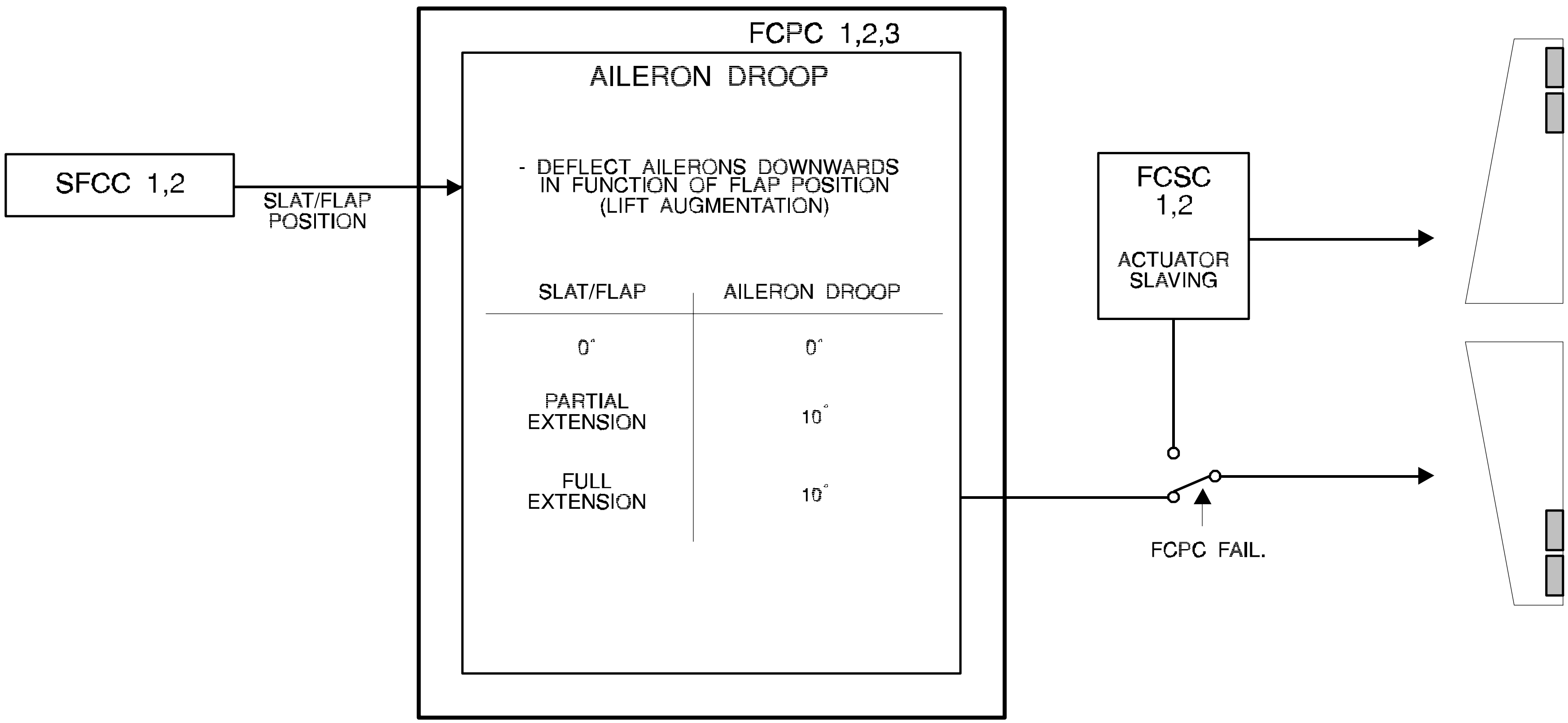
AILERON DROOP FUNCTION

This Function consists in deflecting the inboard and outboard ailerons downwards, depending on the flap and slat position.

The Aileron Droop Function can be engaged on the ground or in flight.



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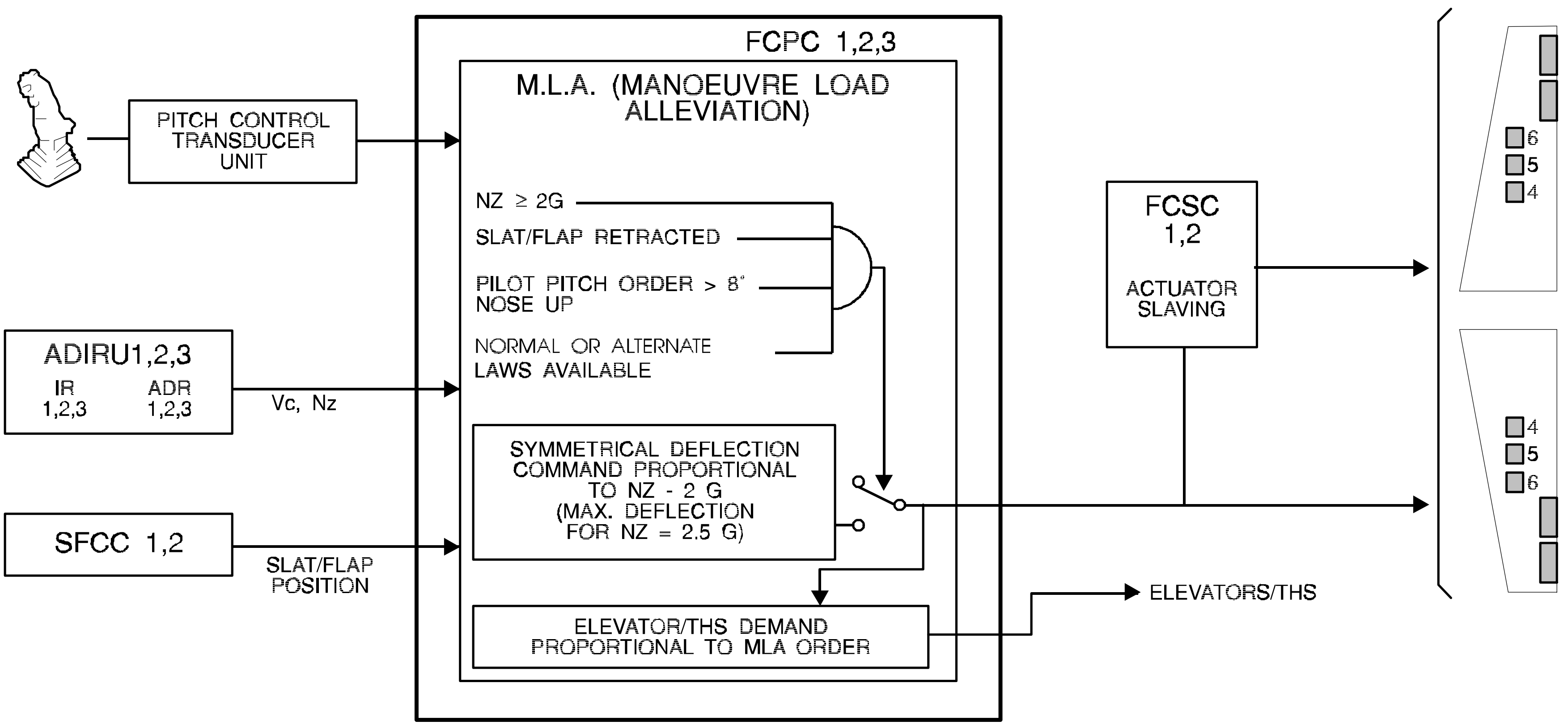
MANEUVER LOAD ALLEVIATION (MLA)

The Maneuver Load Alleviation (MLA) function is activated when the pilot commands, via the side stick, a load factor exceeding a given threshold in clean configuration.

The Maneuver Load Alleviation function has priority over the speed brake function.

The purpose of this function is to reduce the moment due to the loads applied to the wing structure.
This is done by bringing the load application point as close as possible to the wing root.
Spoilers 4,5,6 and ailerons are symmetrically deflected upwards at normal deflection rate.



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STUDENT NOTES:

ELEVATOR SERVO CONTROL DESCRIPTION AND OPERATION

General
Servo Control Pressurization
Active Mode
Damping Mode
Centering Mode
Hydraulic Failure
Electrical Failure
Safety Test

GENERAL

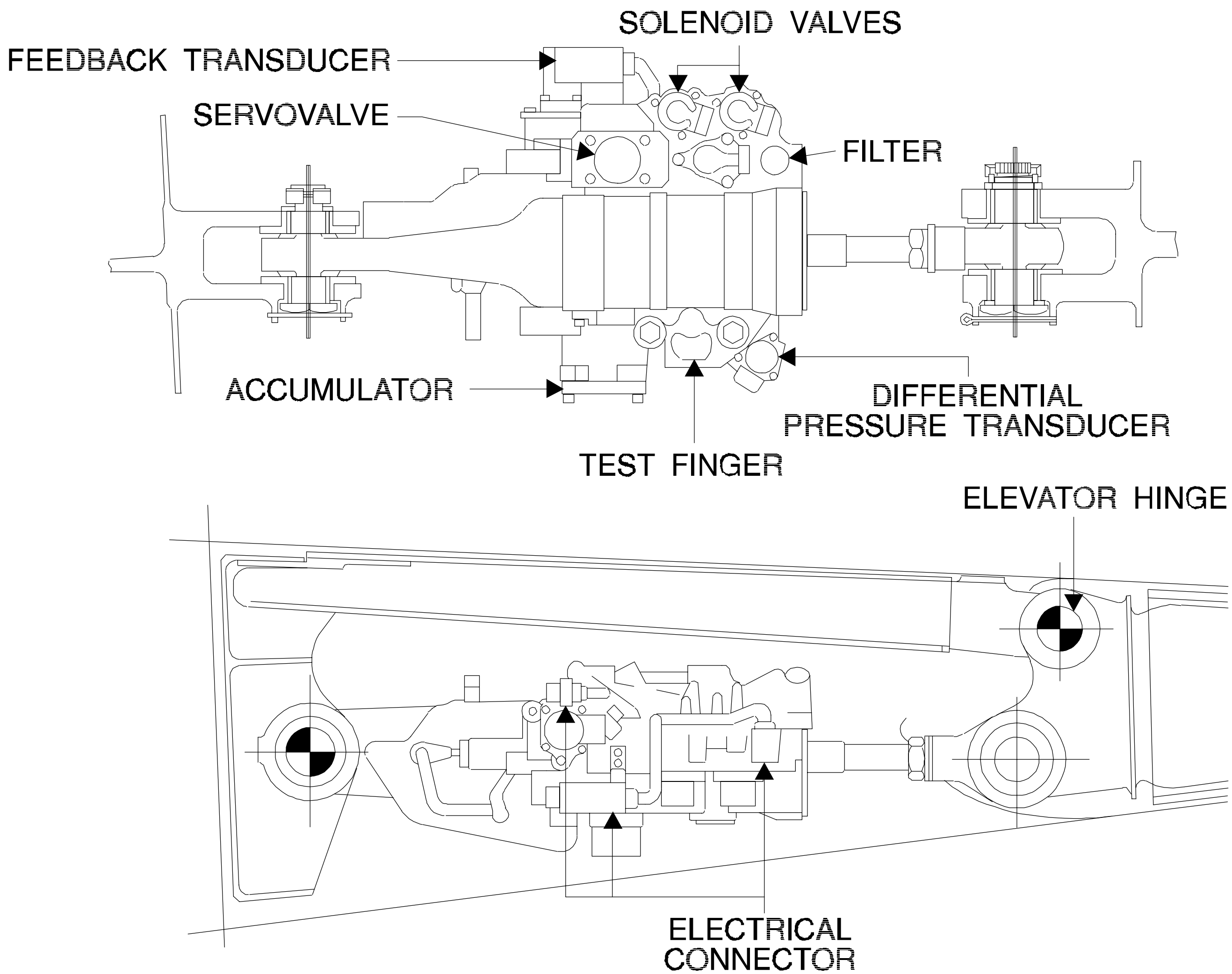
Each elevator is equipped with two interchangeable fixed body electrohydraulic servo controls.

Each servo control (SC) has three modes :

- active,
- damping,•
- centering.

In normal configuration the inner SC is in active mode and the outer is in damping mode.

In the event of large deflection demands combined with aircraft speed, the two servo controls may become active to avoid the saturation of one servo control.



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SERVO CONTROL PRESSURIZATION

The pressurization of the servo control causes the inlet blocking valve and return blocking valve to open.

The pressurization enables the supply of the servovalve by the High Pressure (HP) system and the connection of the servo control return line to the Low Pressure (LP) system.

Inlet blocking valve : High Pressure (HP)
Return blocking valve : Low Pressure (LP)

ACTIVE MODE

In this case, the two solenoid valves are not energized.
This enables the HP fluid to pass and thus put the mode selector valve in the active position.

The two chambers of the actuator are thus connected to the user ports (U1, U2) of the servovalve.
The servo control then operates in active mode.

The mode selector valve transducer (LVDT) transmits the active mode information by an electrical signal to the computers.

When the servovalve receives an electrical order, its jet pipe is deflected.
The HP flow passes into one chamber and moves the actuator.

The feedback transducer (RVDT) transmits the servoloop feedback.

DAMPING MODE

In this configuration, at least one solenoid valve is energized.
The HP flow is stopped and the mode selector valve moves under the action of its spring.

The two chambers are thus interconnected through the damping orifice and anticavitation valves.

The servo control is then in damping mode.
This state is transmitted to the computers by the LVDT.

CENTERING MODE

When the solenoid valves and the servovalve are no longer energized, the servo control is automatically set to the zero position.

The servo control is reset to the zero position by the mechanical input of the servovalve and the feedback linkage.

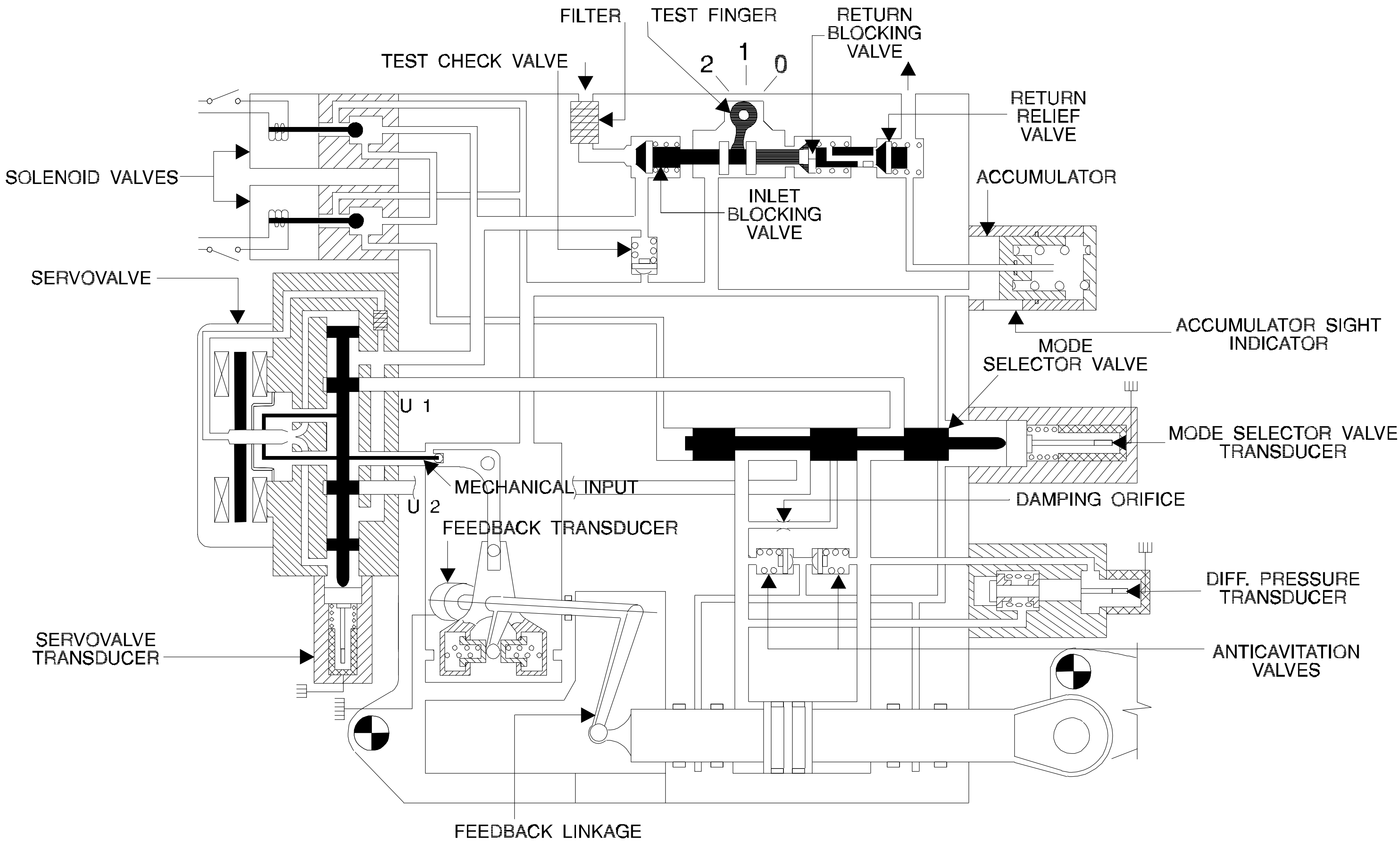
This mode permits the elevator to be brought back and be held in the zero position in the event of electrical control loss.

HYDRAULIC FAILURE

The inlet and return blocking valves close.
The servo control is thus isolated from the aircraft hydraulic system.

The accumulator holds a sufficient volume of fluid to compensate for the variation of temperature and some external leakage.

The mode selector valve moves under the action of its spring.
The servo control operates in damping mode.



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ELECTRICAL FAILURE

After a simple electrical failure, the servo control operates in damping mode. After a total electrical failure, the servo control operates in centering mode.

SIMPLE ELECTRICAL FAILURE :

In the event of a detected servo control failure or of a failure of its two associated computers, one solenoid valve is energized by the computer which controls the adjacent servo control.
The servo control is then in DAMPING MODE.

TOTAL ELECTRICAL FAILURE :

If the electrical control of the servo control is lost, the solenoid valves and the servovalve are no longer energized.
The servo control is then in CENTERING MODE.

SAFETY TEST

The servo control design enables the test of the accumulator, blocking valves and return relief valve to be performed using the accumulator sight indicator and the test finger.

The test finger is manually operated by using an hexagon socket wrench.

Position zero (0) :
- check sealing of inlet and return blocking valves and of return relief valve

Position "leak check" (1) :
- leak check inlet blocking valve and return relief valve.

Position "discharge" (2) :
- check of stroke of accumulator piston.

STUDENT NOTES:

STUDENT NOTES

ELEVATOR COMPONENTS

Servo Control
Transducer Unit

SAFETY PRECAUTIONS

WARNING :

PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :

- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING :

MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.

STUDENT NOTES

SERVO CONTROL

FIN : 2CS1, 3CS1
2CS2, 3CS2

ZONE : 334, 344

COMPONENT DESCRIPTION

The elevator servo controls are electrically controlled fixed body servo controls. They are interchangeable.

AFTER REPLACEMENT

After replacement of the servo control, it is necessary to adjust the actuator rod length.
For this, it is necessary to keep the control surface in the neutral position by servoing the adjacent servo control and screwing in or out the adjustable end fitting on the piston rod.
In order to get more accuracy, it is possible to turn the piston rod.

IN SITU TEST

The servo control design enables the test of the accumulator, blocking valves and relief valve to be performed using the accumulator sight indicator and test finger.

LRU

The components below are Line Replaceable Units
LRUs :

- filter,
- servovalve,
- solenoid valves,
- mode selector valve transducer,
- differential pressure transducer,
- feedback transducer.

TRANSDUCER UNIT

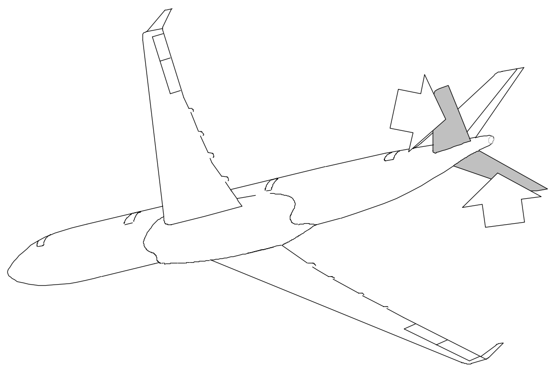
FIN : 4CS1, 4CS2

ZONE : 334, 344

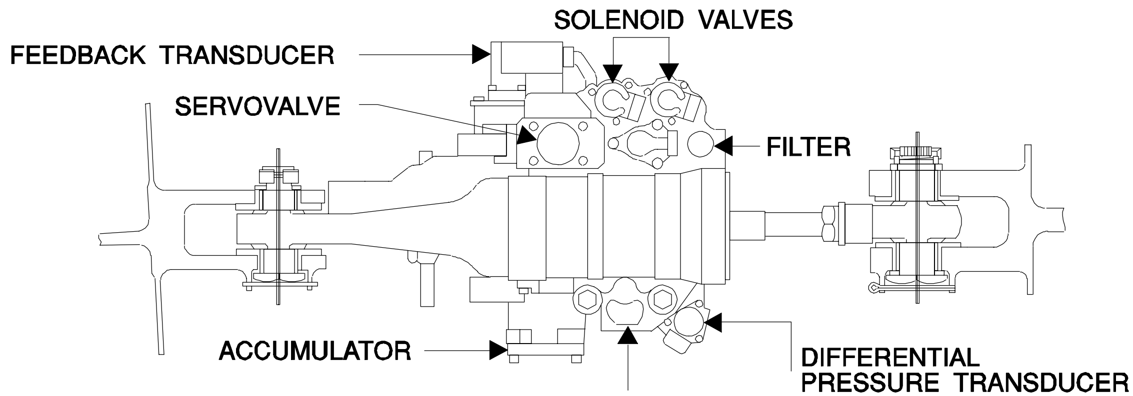
COMPONENT DESCRIPTION

The transducer unit consists of a casing with an attachment base, in which are installed :

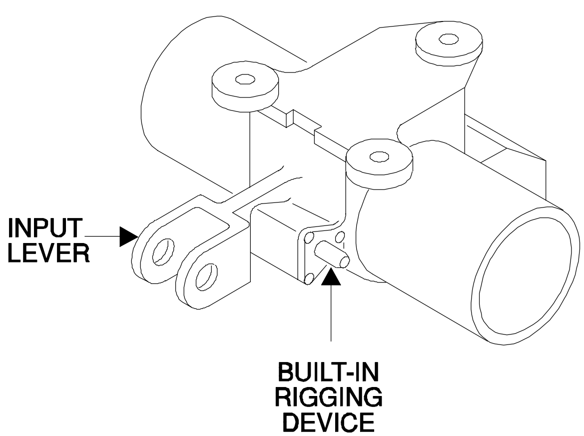
- an input lever whose travel is limited by stops,
- two RVDTs driven by the lever,
- two electrical connectors,
- a built-in rigging device.

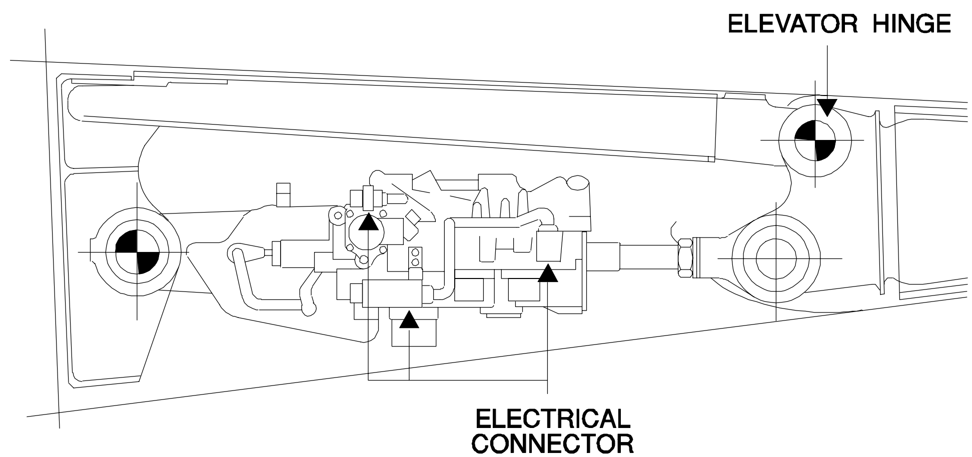


SERVO CONTROL



TRANSDUCER UNIT





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STUDENT NOTES

TRIMMABLE HORIZONTAL STABILIZER ACTUATOR DESCRIPTION AND OPERATION

GENERAL

The Trimmable Horizontal Stabilizer (THS) actuator is an electrohydraulic unit that changes the mechanical or the electrical pitch trim commands into mechanical movement.

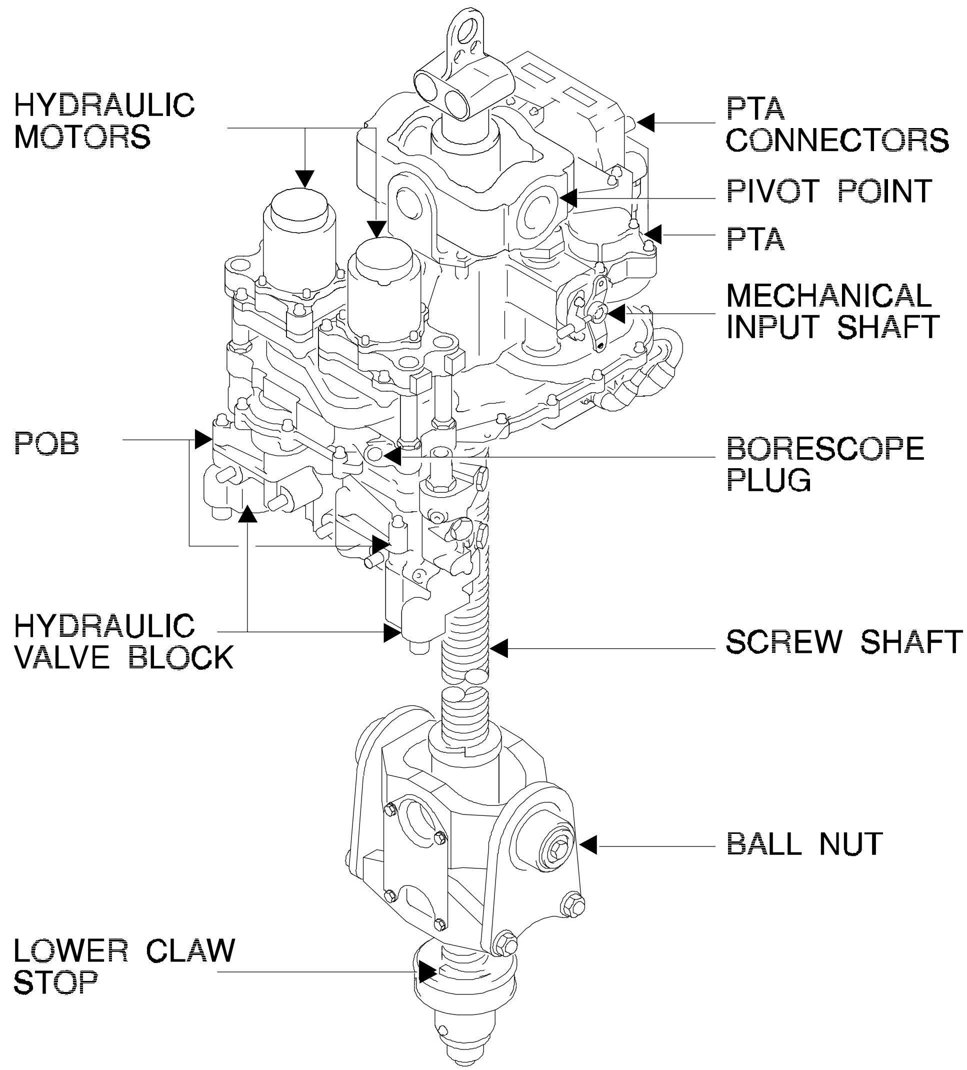
The gear system moves a ball screw jack which is attached to the THS.

The hydraulic actuation is controlled by the Pitch Trim Actuator (PTA).
The PTA has three brushless DC motors, each of which has is own controller.

The controllers are Digital Electronic Modules (DEM).

The DEM has two functions :

- it controls the position of the PTA,
- it controls and monitors its associated motor and clutch.



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NORMAL OPERATION

The FCPC1 transmits the electrical order to the Digital Electronic Module (DEM) motor 1. The DEM operates the motor 1 which drives the control valves.

As soon as hydraulic power is applied to the Pressure Off Brakes (POB) of the hydraulic motors. The POBs are released.

The control valve opens and lets hydraulic fluid go into the hydraulic motors. Both hydraulic motors operate at the same time and drive the ball screw jack. The ball screw jack has a feedback gear which is attached to a control differential input.
The movement of the ball screw jack is compared with the control input signal applied to the control differential input.
The difference between the two signals is shown at the control differential output which moves the control valve.

When the THS actuator gets to the position demanded by the FCPC1, the PTA output stops, the control valve is closed by the feedback gear and stops the hydraulic flow to the motors.

The command RVDTs transmit the PTA output position to the DEMs The monitor RVDTs transmit the ball screw jack position to the FCPCs monitor channels.

MECHANICAL OPERATION

The trim wheels transmit the mechanical order to the override mechanism.

The input shaft moves the mechanical servoloop through an override mechanism.
It cancels the electrical control by operating the three override micro switches.

JAMMING

If one control valve jams in a position which exceeds detection limits of the brake control differential, the hydraulic supply of both hydraulic motors will be cut by the shutoff valve in each valve block.

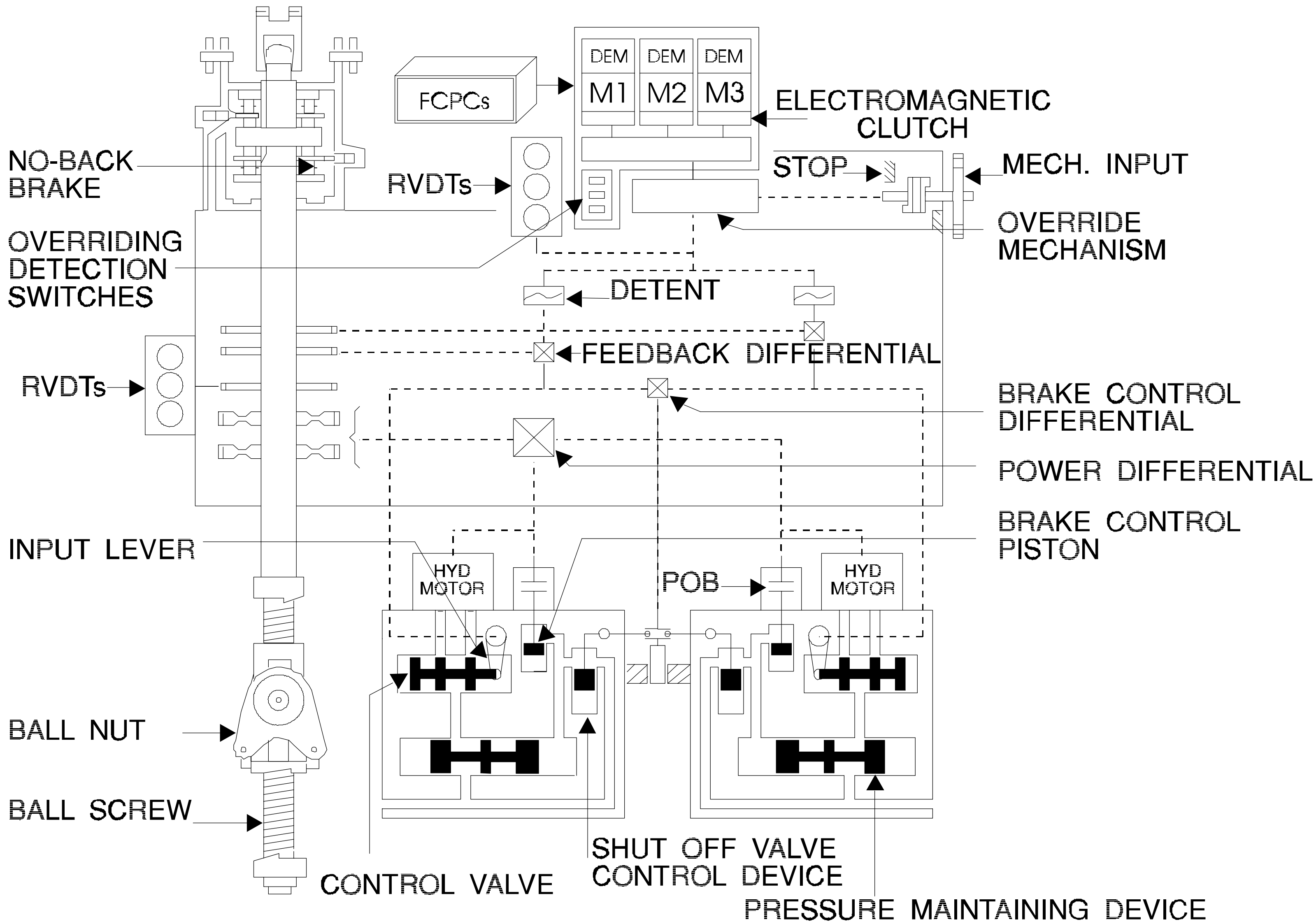
Both POBs are applied. The THS is immobilized and locked. A mechanical indicator pops out and shows the jamming.

If the control valve jams in a position which does not exceed the detection limits of the brake control differential, the feedback gear moves the serviceable control valve in the opposite direction.
The hydraulic motors are driven in opposite directions. The THS actuator is always controlled.

HYDRAULIC FAILURE

If one hydraulic supply to the THS actuator fails, the associated POB is applied. The POB stops and holds the hydraulic motor shaft. The power differential operates with reduced speed.

If there is a complete loss of hydraulic power to the THS actuator, the POBs and no-back brakes operate. The THS is immobilized and locked.



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STUDENT NOTES:

TRIMMABLE HORIZONTAL STABILIZER COMPONENTS

THS Actuator
Pitch Trim Actuator (PTA)
Hydraulic Motors
Hydraulic Valve Block
Pressure Off Brake (POB)

SAFETY PRECAUTIONS

WARNING :

PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :

- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING :

MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.

STUDENT NOTES

THS ACTUATOR

The THS actuator is an electro-hydraulic unit used to move the THS. Its components are :

- two hydraulic motors (LRU)
- two valve blocks
- two Pressure Off Brakes (POB)
- a ball screw jack
- a mechanical input shaft with a rigging pin
- a Pitch Trim Actuator (PTA) (LRU)

FIN : 1CS

ZONE : 330

COMPONENT DESCRIPTION

The PTA controls the THS actuator. The blue and yellow hydraulic systems supply the motors. The hydraulic motors operate the ball screw jack.
A differential gear connects the hydraulic motors.
The valve blocks are controlled by the PTA or the mechanical input shaft.

SERVICING

The actuator is equipped with an oil filler plug. The oil level is checked through a sight glass window.
This window is located on the upper half of the gearbox case.

PITCH TRIM ACTUATOR (PTA)

The PTA controls the THS actuator and it has :

- three brushless DC motors,
- three Digital Electronic Modules (DEMs) which are attached to the PTA.

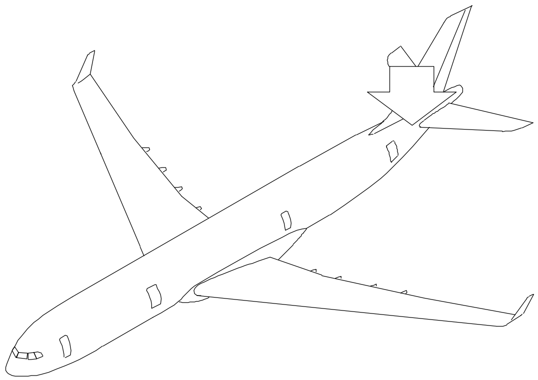
Two position transducer packs (RVDTs) are associated to the PTA.
The RVDT packs and the DEMS are LRUs.

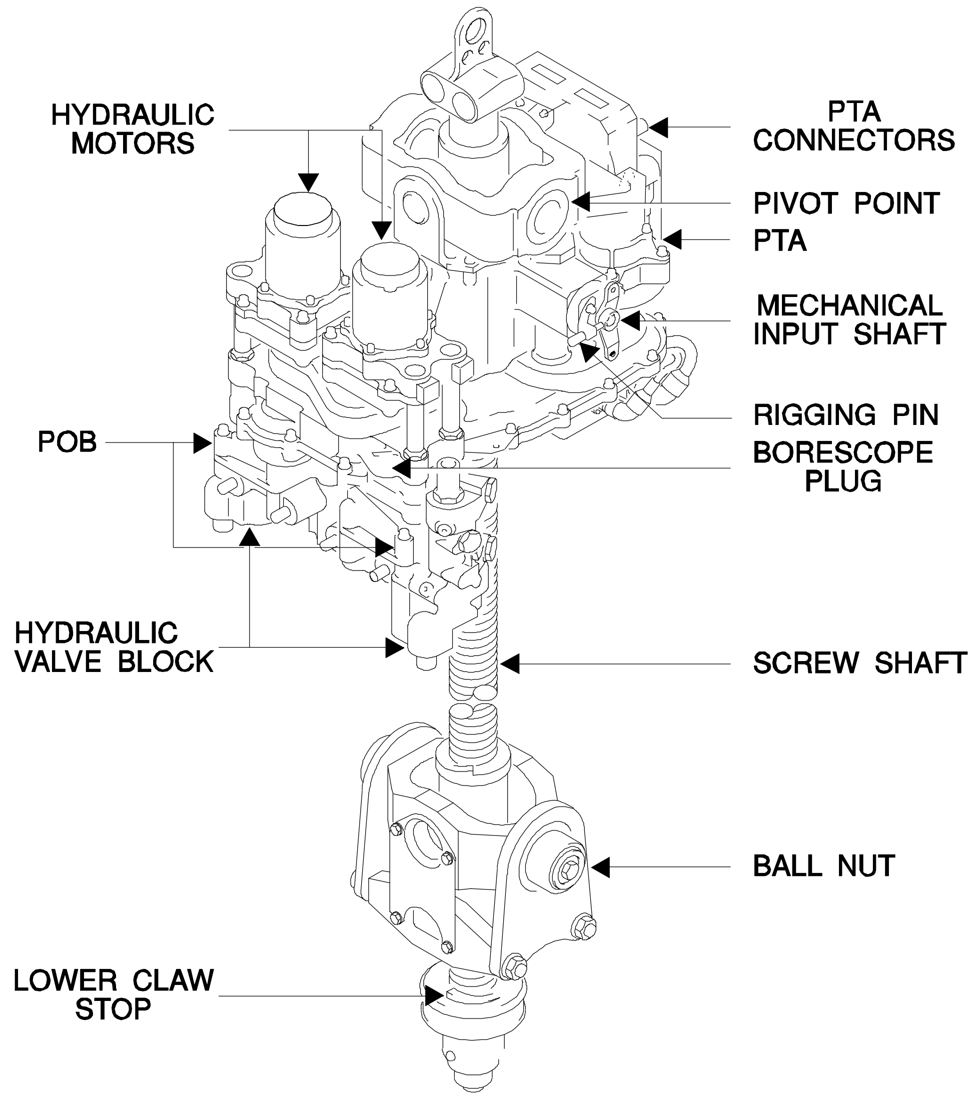
COMPONENT DESCRIPTION

One pack monitors the position of the ball screw jack, the other monitors the output position of the PTA. Each pack includes three Rotary Variable Differential Transducers (RVDT).
Each DEM is a self contained unit. During the operational cycle of the THS actuator, the DEM does several self-test procedures.

AFTER REPLACEMENT

After replacement of the RVDT packs, no adjustment is required.





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HYDRAULIC MOTORS

The hydraulic motors operate the ball screw jack which moves the THS.
Each hydraulic motor has one Pressure Off Brake (POB) and one valve block.

HYDRAULIC VALVE BLOCK

The two valve blocks control the operation of the THS.

Each valve block has :

- a control valve,
- a pressure maintaining device and shut-off valve,
- a shut-off valve control device,
- a filter (LRU)

Its operation is explained in module "THS actuator D/O".

PRESSURE OFF BRAKE (POB)

The POBs stop the hydraulic motors and the ball screw jack in case of failure.

Pressure ON : brakes released
Pressure OFF : brakes applied

The POB can be released during maintenance by means of a special tool.

LATERAL CONTROL NORMAL DESCRIPTION AND OPERATION (ROLL AXIS)

Manual Flight
Autoflight
Laws
Maneuver Load Alleviation (MLA)

MANUAL FLIGHT

In normal configuration, Flight Control Primary Computer 1 (FCPC1) computes the roll orders and transmits them to the other computers for the servoloop control.

Inboard (INNER) ailerons :

* FCPC1 controls the green servo control for the left side.
* FCPC2 controls the blue servo control for the right side.
* The blue left and the green right servo controls are in damping mode.

The outboard ailerons are controlled by FCPC3 which controls the yellow servo control for the left side and the green servo control for the right side.

The roll spoilers are controlled by the FCPCs or the FCSCs affected to the servo controls.

The roll command has priority over the speed brake function and the aileron droop function.

AUTOFLIGHT

When the Autopilot is engaged, FCPC1 takes into account the AutoPilot (AP) orders transmitted by the Flight Management and Guidance Envelope Computer (FMGECs).
It transmits to the other flight control computers which ensure their servoing functions.

The priorities for flight control computer engagement, as regards control and servoing, remain the same as in manual mode.

- The side sticks are maintained in neutral position by a solenoid operated load threshold device.
- The autopilot disengagement is requested by the FCPCs when an excessive bank angle is met.

LAWS

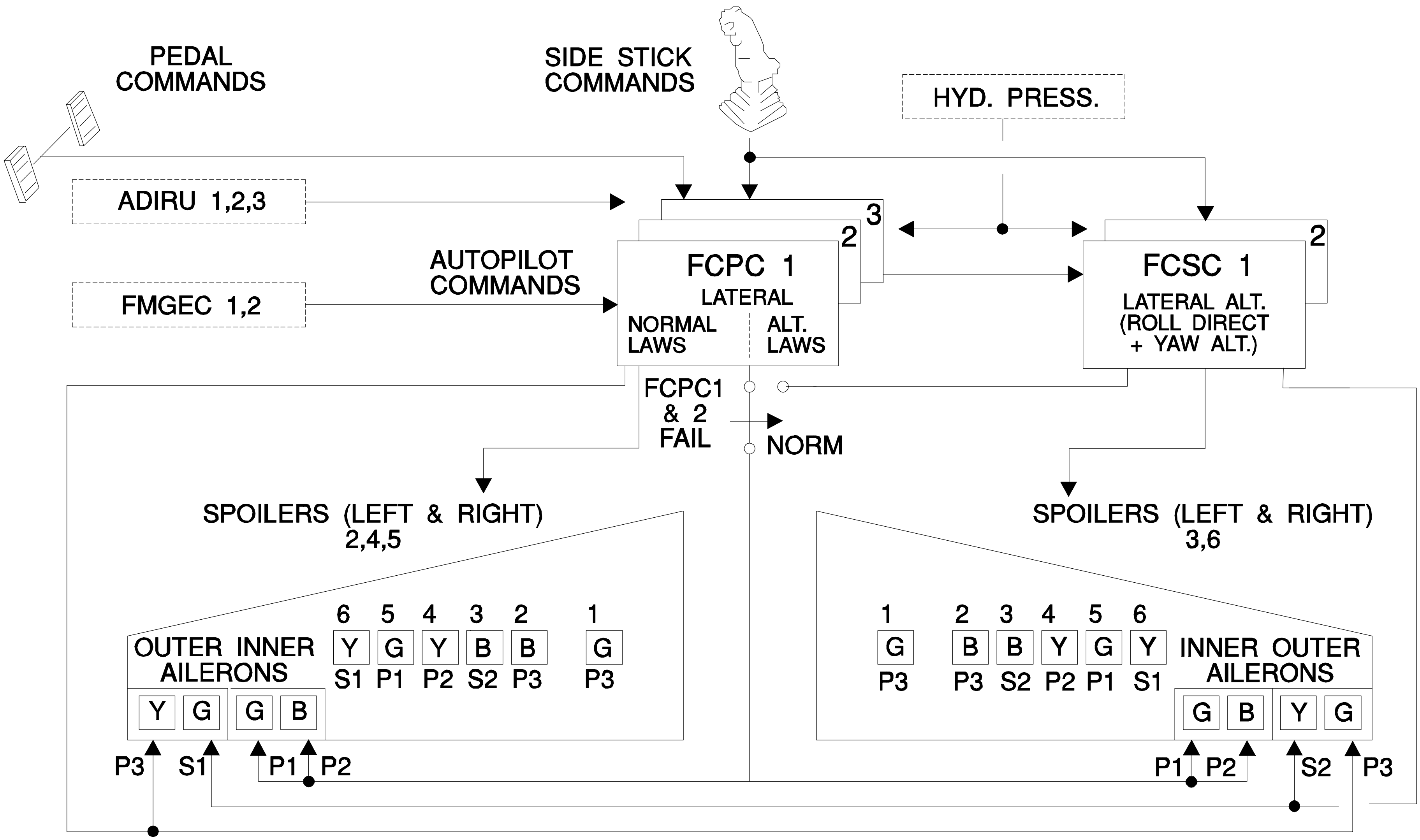
In normal configuration, the lateral normal law, computed in FCPC1, is activated in flight and in flare mode.
On ground, the lateral ground law is used.

In flight and in flare mode, the bank angle protection is active.
It is included in the lateral normal law.
By a roll action on the stick, the pilot commands a roll rate with a minimized sideslip.

MANEUVER LOAD ALLEVIATION (MLA)

The Maneuver Load Alleviation function is computed in FCPC1 in normal conditions.

The Maneuver Load Alleviation (MLA) function is activated when the pilot commands, via the side stick, a load factor exceeding 2g in clean configuration.



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STUDENT NOTES:

LATERAL CONTROL NORMAL DESCRIPTION AND OPERATION (YAW AXIS)

Manual Flight
Autoflight
Laws

MANUAL FLIGHT

In normal conditions, the pilot does not use the rudder pedals.
From the sticks, the rudder, associated with the roll surfaces, automatically ensures the turn coordination and the damping of the dutch roll.

The yaw damper servo actuators form the main electrical inputs of the rudder control.

Flight Control Primary Computer 1 (FCPC1) controls the green yaw damper servo actuator which is in active mode.
The Back up Yaw Damper Unit (BYDU) is in standby mode.

The rudder trim actuator is servoed and monitored by Flight Control Secondary Computer 1 (FCSC1).
It is controlled by the crew acting on the trim control panel where the trimmed position indication is displayed.

The commanded deflection of the rudder is limited by the Rudder Travel Limitation Unit (RTLU), controlled by FCSC1.
The pedal travel is limited by the Pedal Travel Limitation Unit (PTLU) controlled by FCSC1.

Motor 1 of the rudder trim actuator, motor 1 of the PTLU and motor 1 of the RTLU are in active mode, each motor 2 is in standby.

AUTOFLIGHT

In autopilot mode, the Flight Management Guidance and Envelope Computers (FMGECs) send the control orders to the FCPCs which control the yaw damper servo actuators, and via the FCSCs, the trim actuators.

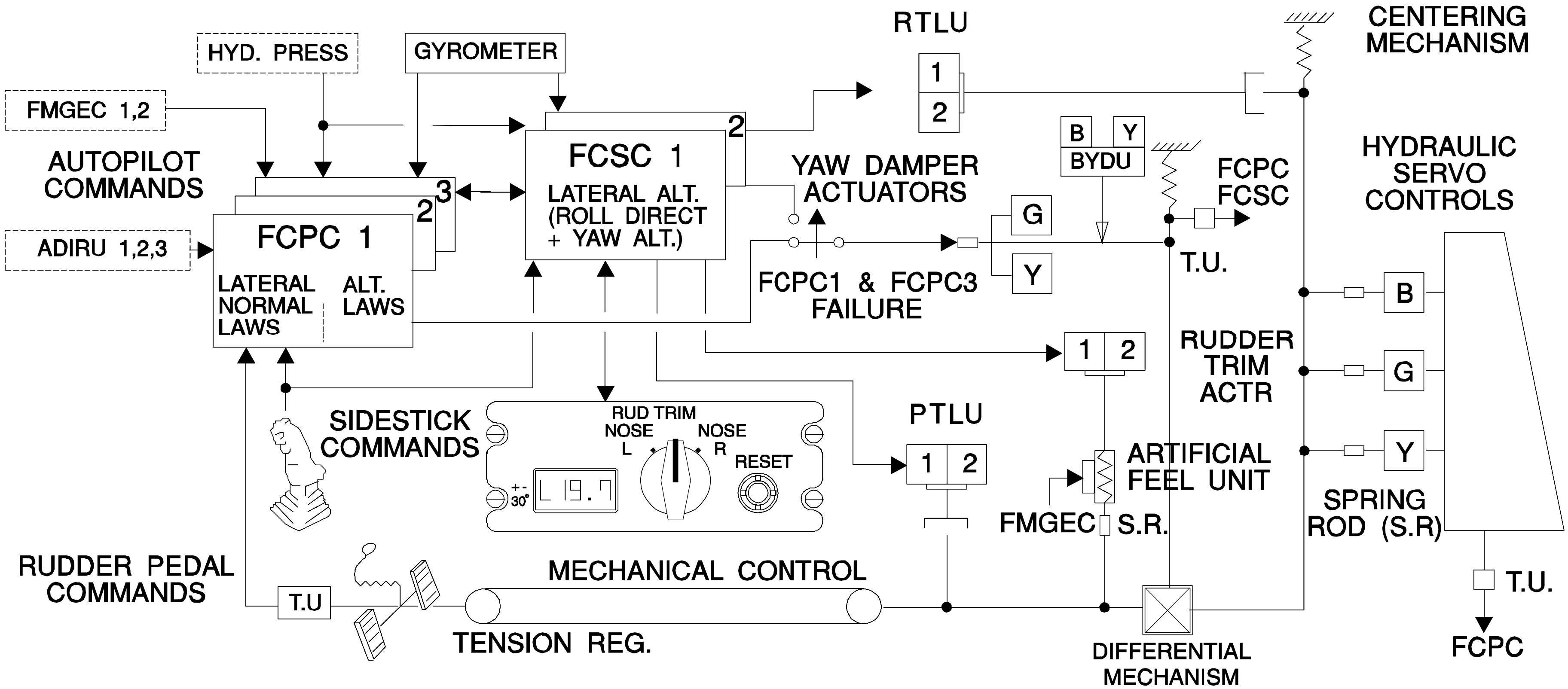
- The artificial feel on the rudder control is locked by a solenoid and replaced by an AutoPilot (AP) artificial spring rod intended to noticeably increase the loads on the rudder pedals.
- The AP is disengaged by moving the pedals, thus overriding the spring rod which holds them in neutral position.

LAWS

In normal configuration and in manual mode, FCPC1 computes the yaw deflection orders following the lateral normal law in flight and in flare mode, and following the ground law in ground mode.

- A roll action on the stick commands a roll rate with minimized sideslip.
- Action on the pedals commands a sideslip which will induce a bank angle; the roll spoilers and the ailerons will counter this enduced roll: in normal operation, no pedal input is required.

NOTE: The rudder must not be used to induce roll when normal roll control is available.



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STUDENT NOTES:

LATERAL CONTROL ABNORMAL OPERATION

Computer Failures
Servo Control Failures
Alternate Law
Manoeuver Load Alleviation (MLA)

COMPUTER FAILURES

A computer failure can engage a lateral abnormal configuration.

- The loss of Flight Control Primary Computer 1 (FCPC1) causes the loss of spoiler 5 actuation.

FCPC2 :

* Computes the lateral orders in normal laws and transmits them to the other computers for the servoloop control.

FCSC1 :

* Performs the rudder trim and TLU control.

- In case of loss of all FCPCs, only spoilers 3, 6 are available and controlled by the FCSCs.
The yaw damper and the ailerons are servoed by the FCSCs and the normal law is lost.

FCSC1 :

* Computes the lateral orders in alternate laws and transmits them to FCSC2

* Performs the rudder trim and TLU control.

- The loss of FCPC1 and of the two FCSCs causes the loss of spoiler 3, 5 and 6 actuation.
The rudder trim actuator and the Travel Limitation Units (TLUs) can no longer be controlled.

- If all the computers are lost, only the mechanical back-up remains available.
The lateral control of the aircraft is achieved with the pedals (MECHANICAL CONTROL).

The Back up Yaw Damper Unit (BYDU) is activated and computes a yaw damping order.

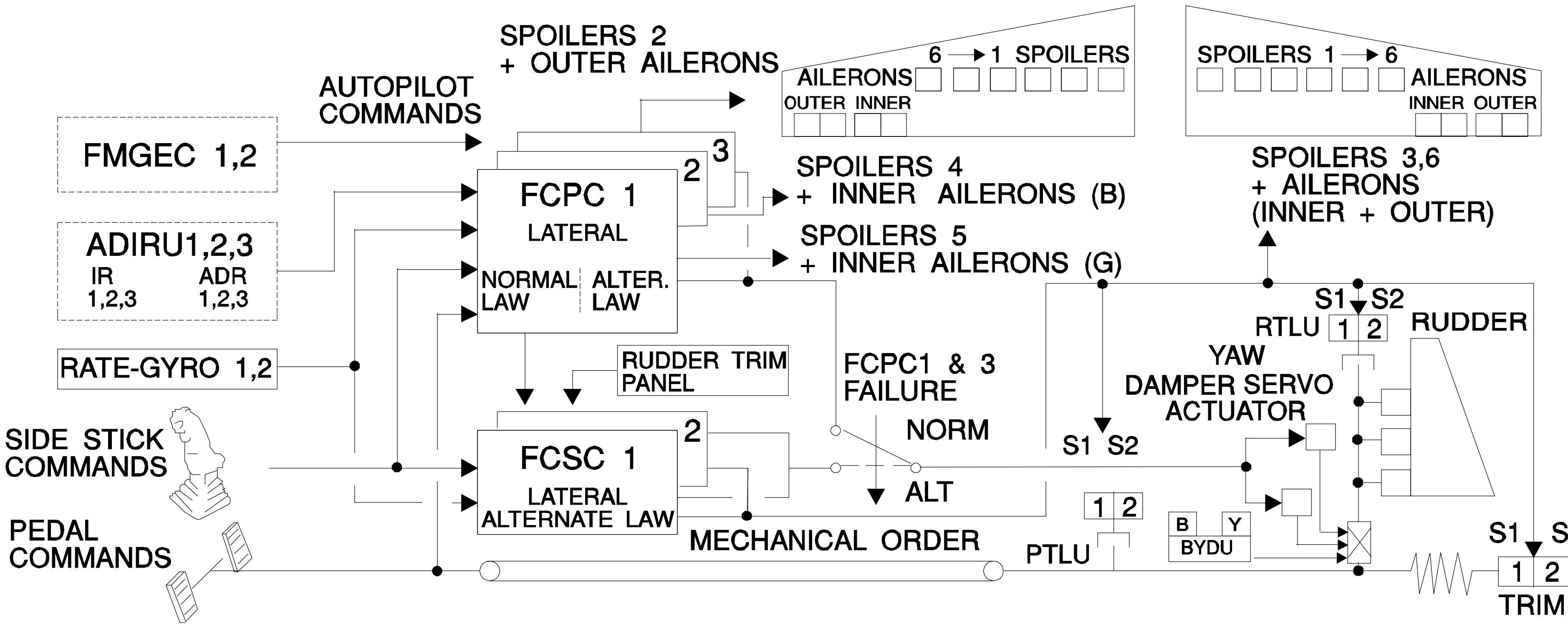
SERVO CONTROL FAILURES

- In the event of loss of servoing on one inboard aileron servo control, the FCPCs having priority are symmetrically disengaged from the two left and right servo controls that they drive.
If one FCSC is engaged, it is disengaged, in the event of electrical failure, on the failed side only.

- In the event of loss of servoing of one outboard aileron servo control, FCPC3 is disengaged on the failed side in favor of FCSC, but remains engaged on the valid servo control on the other wing.

- In the event of loss of servoing of one spoiler servo control, the symmetric servo control is also disengaged.

- In case of loss of servoing on the two yaw damper servo actuators (hydraulic or electrical failures), the Back up Yaw Damper Unit (BYDU) is activated and computes the yaw damping order.


SPOILERS 2
+ OUTER AILERONS
AUTOPILOT COMMANDS
6 → 1 SPOILERS
AILERONS
OUTER INNER
SPOILERS 1 → 6
AILERONS
INNER OUTER
FMGEC 1,2
ADIRU1,2,3
IR 1,2,3
ADR 1,2,3
RATE-GYRO 1,2
FCPC 1
LATERAL
NORMAL LAW
ALTER. LAW
2
3
SPOILERS 4
+ INNER AILERONS (B)
SPOILERS 5
+ INNER AILERONS (G)
SPOILERS 3,6
+ AILERONS
(INNER + OUTER)
RUDDER TRIM PANEL
FCPC1 & 3 FAILURE
NORM
ALT
S1 S2
RTLU 1 2
RUDDER
YAW
DAMPER SERVO
ACTUATOR
SIDE STICK COMMANDS
FCSC 1
LATERAL
ALTERNATE LAW
2
PEDAL COMMANDS
MECHANICAL ORDER
PTLU 1 2
B Y
BYDU
S1 S2
1 2
TRIM

ALTERNATE LAW

In case of loss of lateral surface actuation or information, the lateral normal law is disengaged and replaced by the lateral alternate law.
This law is composed of roll direct and yaw alternate.

The lateral alternate law is activated in the FCPCs or in the FCSCs in case of loss of :

- 2 ADR (Air Data Reference) or
- 2 Inertial Reference (IR), information of 3rd IR is consolidated by the yaw rate gyrometers or
- All roll spoiler actuations or all inner aileron actuations or
- Pedal transducers.

In alternate law, only spoilers 4 to 6 are used for roll control, in order not to have too much roll rate.
Spoilers 2 and 3 are not used except in case of green hydraulic failure, loss of all FCPCs or yaw damper loss.

MANOEUVER LOAD ALLEVIATION (MLA)

The MLA function is lost in direct law configuration

SETUDENT NOTES:

STUDENT NOTES

LATERAL LAWS

Ground Law
Normal Flight/Flare Law
Alternate Flight/Flare Law
Abnormal Attitude Law
Sideslip Estimation
Beta Target

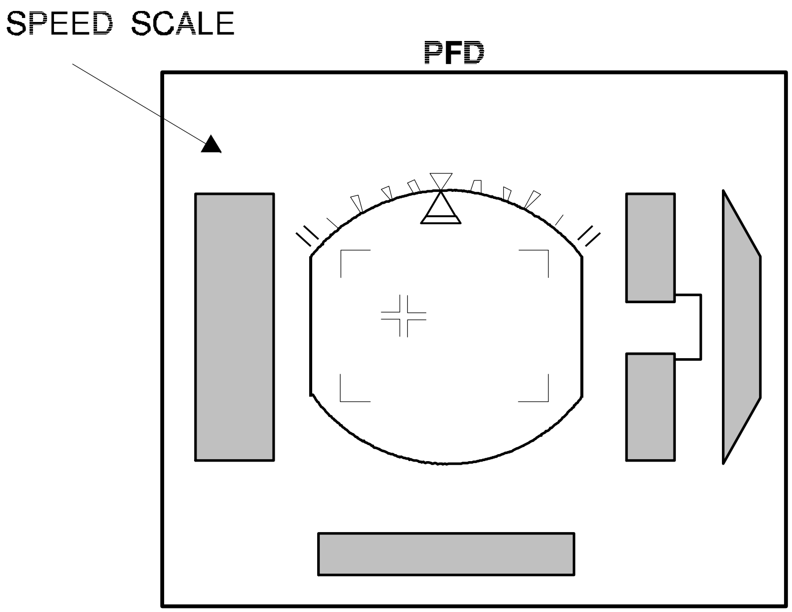
GROUND LAW

This law is engaged during the ground mode.
It can be computed in the Flight Control Primary Computers (FCPCs) and in the FCSCs.

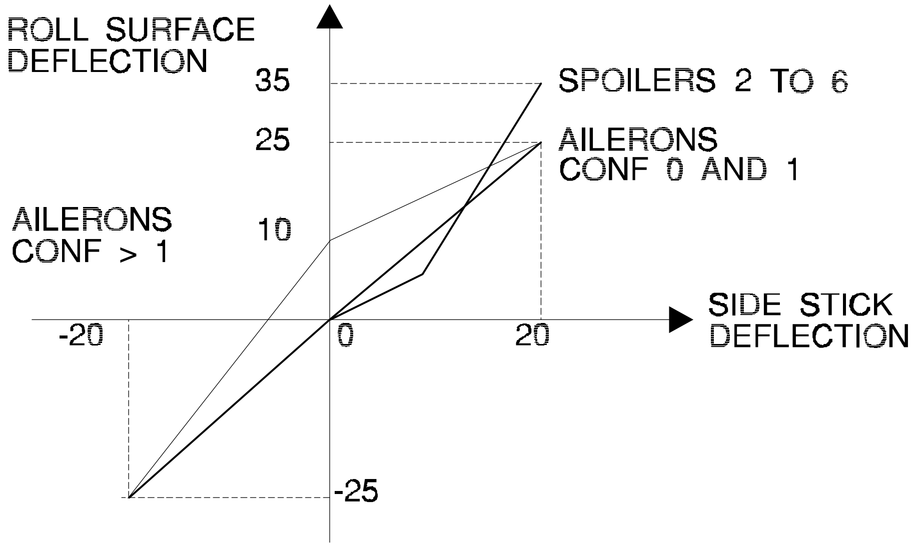
The lateral Ground Law is similar to the lateral Alternate Law :

- The roll control is direct, an order on the side stick directly commands a proportional surface deflection.
- The yaw control is alternate, it is achieved from the pedals.

A dutch roll damping function is introduced via the yaw damper servo actuators.



lateral load factor indication



The kinematic for the spoilers 2 to 6 depends on the aircraft configuration.

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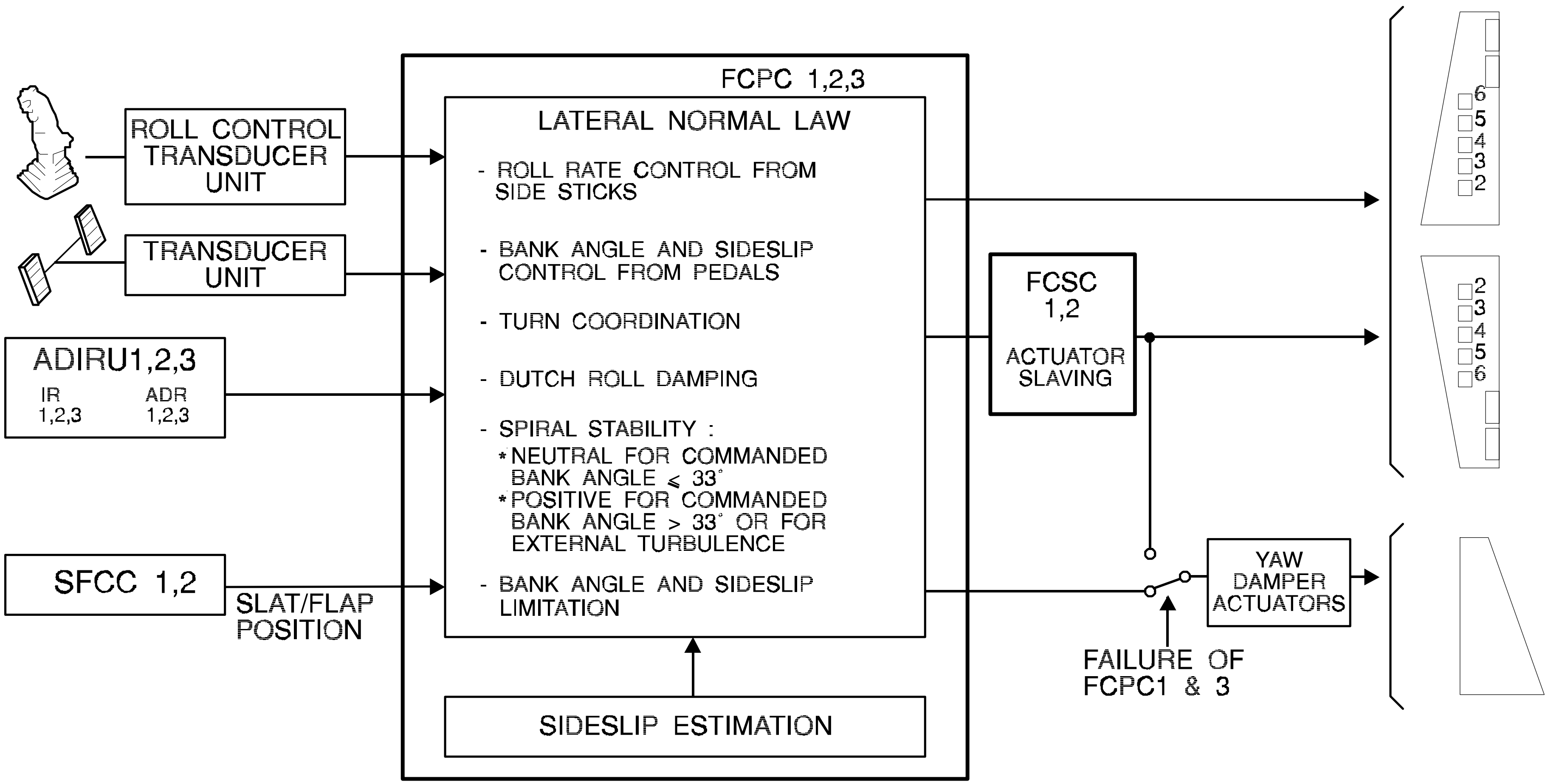
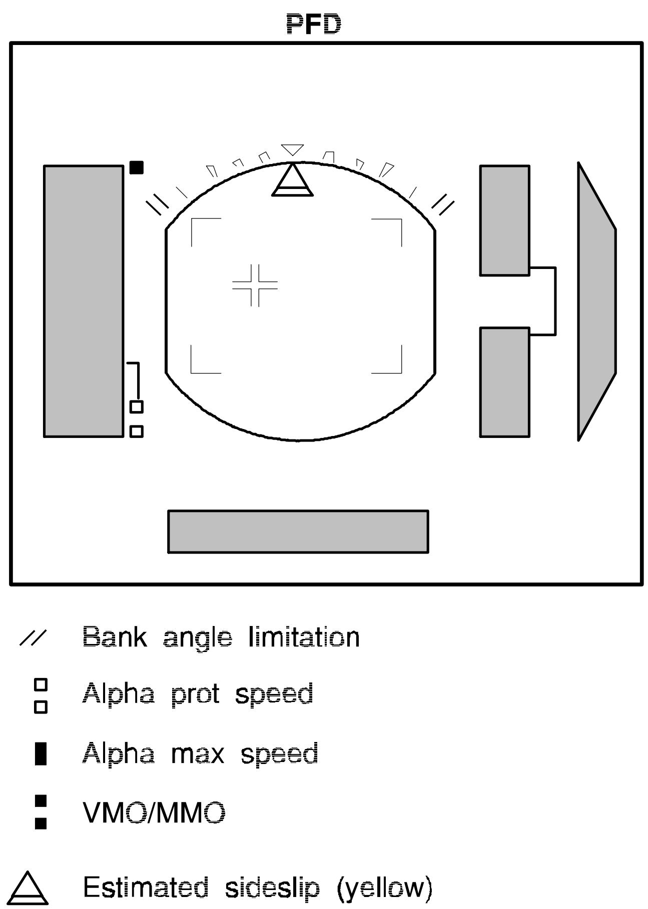
NORMAL FLIGHT/FLARE LAW

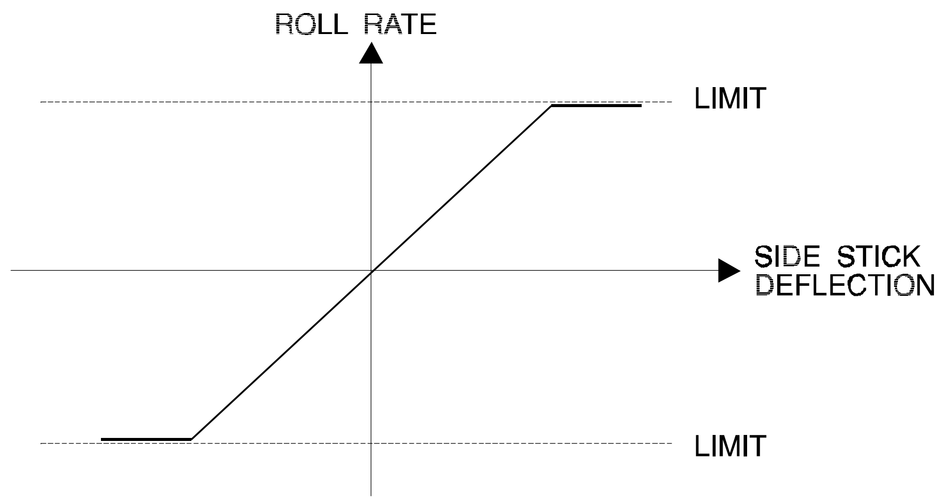
The lateral Normal Law is used for the lateral control in normal conditions. The pilot commands a roll rate with minimized sideslip through a roll action on the stick.

In normal conditions, this law is engaged in flight and in flare mode.


FCPC 1,2,3
LATERAL NORMAL LAW
- ROLL RATE CONTROL FROM SIDE STICKS
- BANK ANGLE AND SIDESLIP CONTROL FROM PEDALS
- TURN COORDINATION
- DUTCH ROLL DAMPING
- SPIRAL STABILITY :
*NEUTRAL FOR COMMANDED BANK ANGLE ⩽ 33°
*POSITIVE FOR COMMANDED BANK ANGLE > 33° OR FOR EXTERNAL TURBULENCE
- BANK ANGLE AND SIDESLIP LIMITATION
SIDESLIP ESTIMATION
ROLL CONTROL TRANSDUCER UNIT
TRANSDUCER UNIT
ADIRU1,2,3
IR 1,2,3
ADR 1,2,3
SFCC 1,2
SLAT/FLAP POSITION
FCSC 1,2
ACTUATOR SLAVING
YAW DAMPER ACTUATORS
FAILURE OF FCPC1 & 3
6
5
4
3
2
2
3
4
5
6

INDICATING & SCHEMATICS



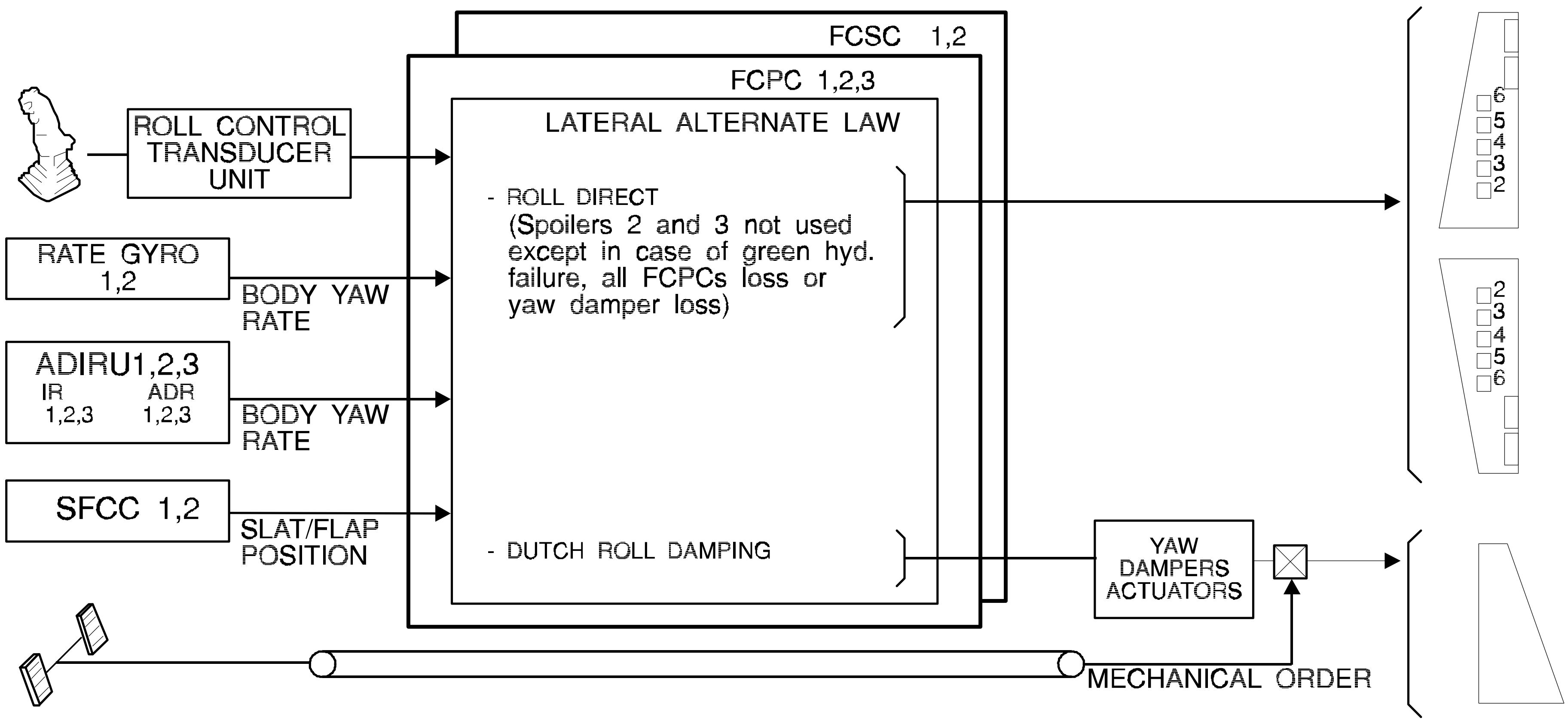


Ailerons and spoiler kinematics are function of aircraft configuration. In addition, the spoiler 2 and 3 kinematics differ from spoiler 4/5/6 kinematics.

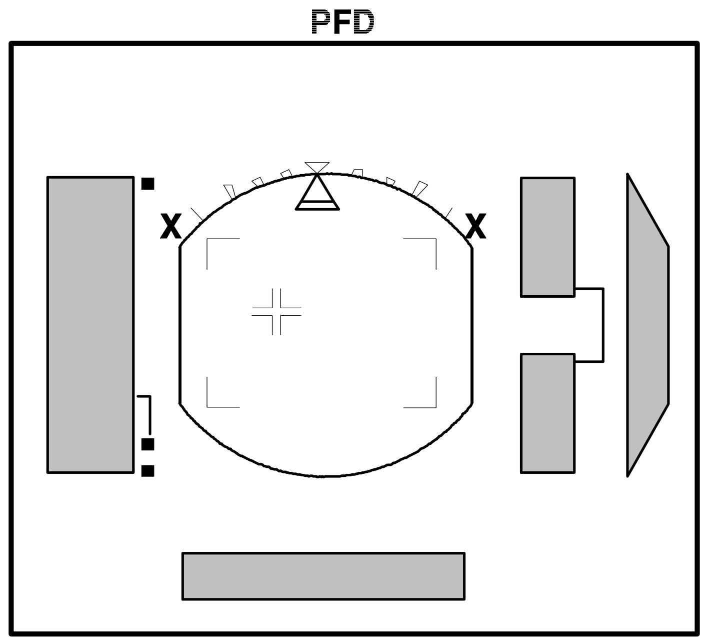
ALTERNATE FLIGHT/FLARE LAW

This Law is engaged in the event of loss of Normal Law.
It consists of roll direct and yaw alternate without turn coordination.

This law can be engaged in each mode because the ground law is the same law.


FCSC 1,2
FCPC 1,2,3
LATERAL ALTERNATE LAW
ROLL CONTROL TRANSDUCER UNIT
- ROLL DIRECT
(Spoilers 2 and 3 not used except in case of green hyd. failure, all FCPCs loss or yaw damper loss)
RATE GYRO 1,2
BODY YAW RATE
ADIRU1,2,3
IR 1,2,3
ADR 1,2,3
BODY YAW RATE
SFCC 1,2
SLAT/FLAP POSITION
- DUTCH ROLL DAMPING
YAW DAMPERS ACTUATORS
MECHANICAL ORDER
6
5
4
3
2
2
3
4
5
6

INDICATING & SCHEMATICS

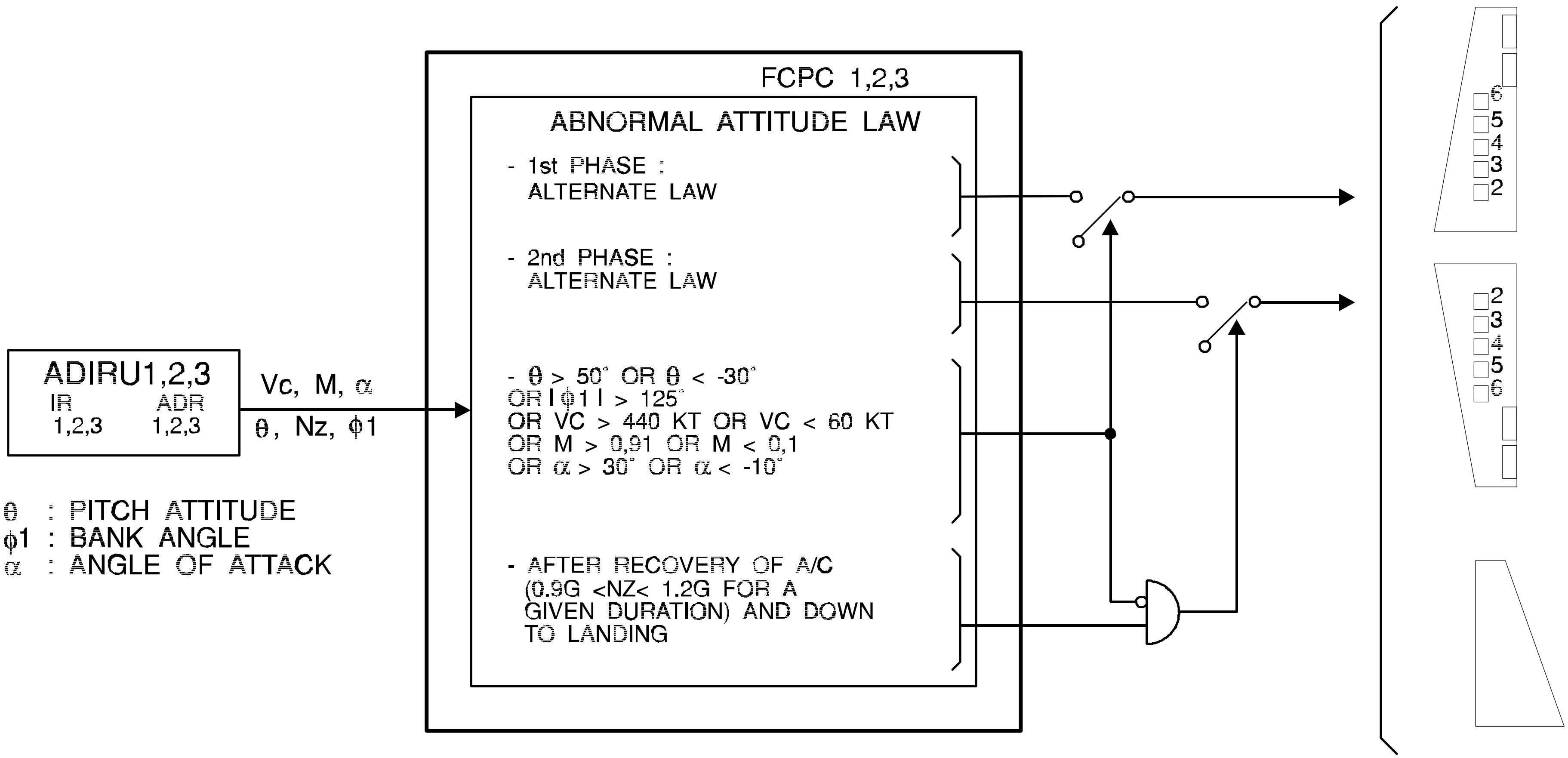


△ Estimated sideslip replaced by lateral acceleration.

X Bank angle limitation is not available.

ABNORMAL ATTITUDE LAW

This Law is engaged when certain aircraft flight parameters exceed predetermined values.



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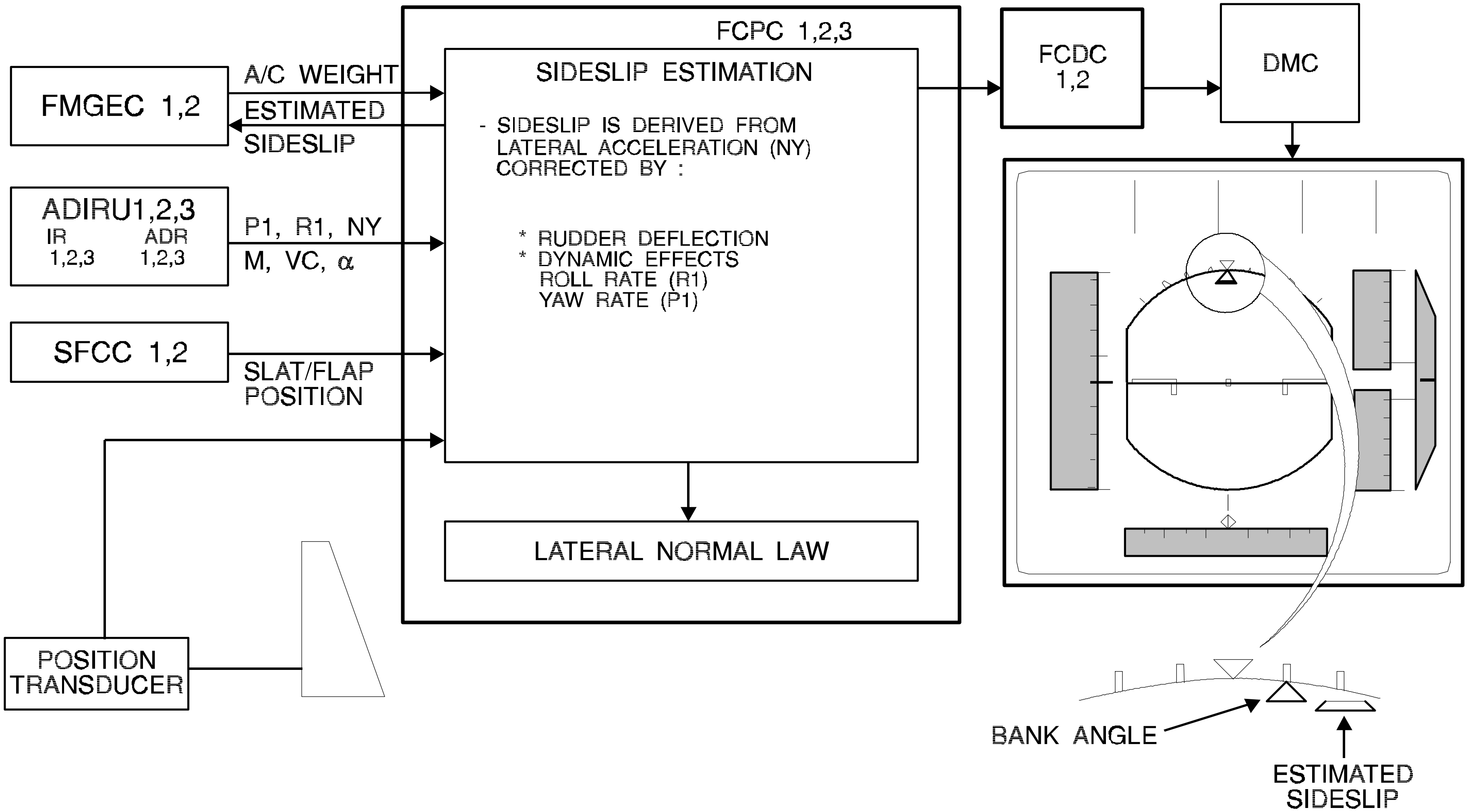
SIDESLIP ESTIMATION

The Estimated Sideslip is used as an input parameter for the Lateral Normal Law.
It is sent to the Data Management Computers (DMCs) by the Flight Control Data Concentractors (FCDCs) for display on the Primary Flight Display (PFD).



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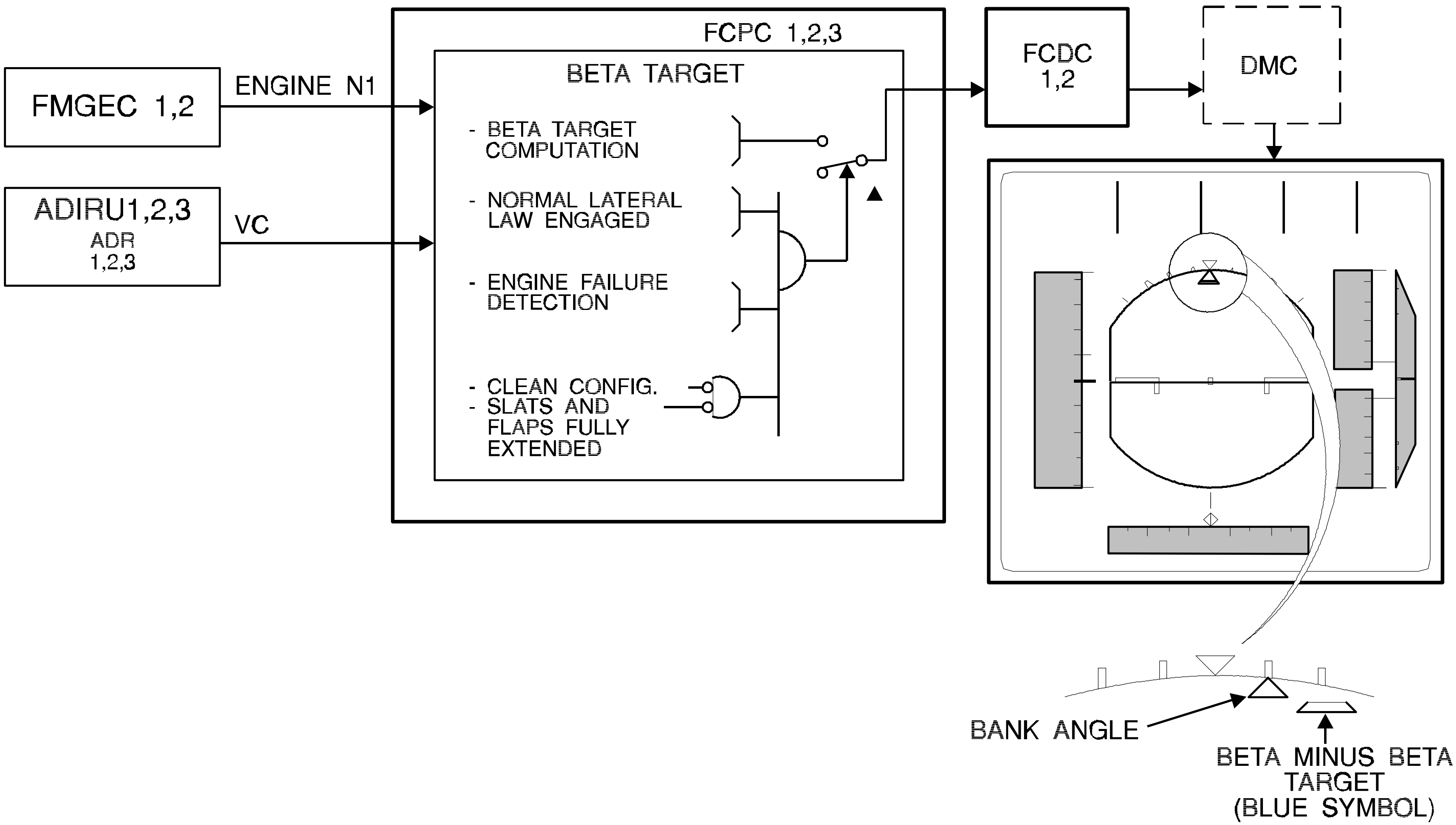
BETA TARGET

The Beta Target function is activated in the flight mode further to an engine failure, when the Lateral Normal Law is engaged.

- In order to obtain the best drag in case of engine failure, the sideslip leading to optimum trim of the aircraft is computed : BETA TARGET

- The objective is to center the blue symbol difference between actual sideslip and Beta Target in the direction of motion according to pedal actions as that of conventional ball.



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STUDENT NOTES:

AILERON SERVO CONTROL DESCRIPTION AND OPERATION

General
Servo Control Pressurization
Active Mode
Damping Mode
Hydraulic Failure
Electrical Failure
Safety Test

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GENERAL

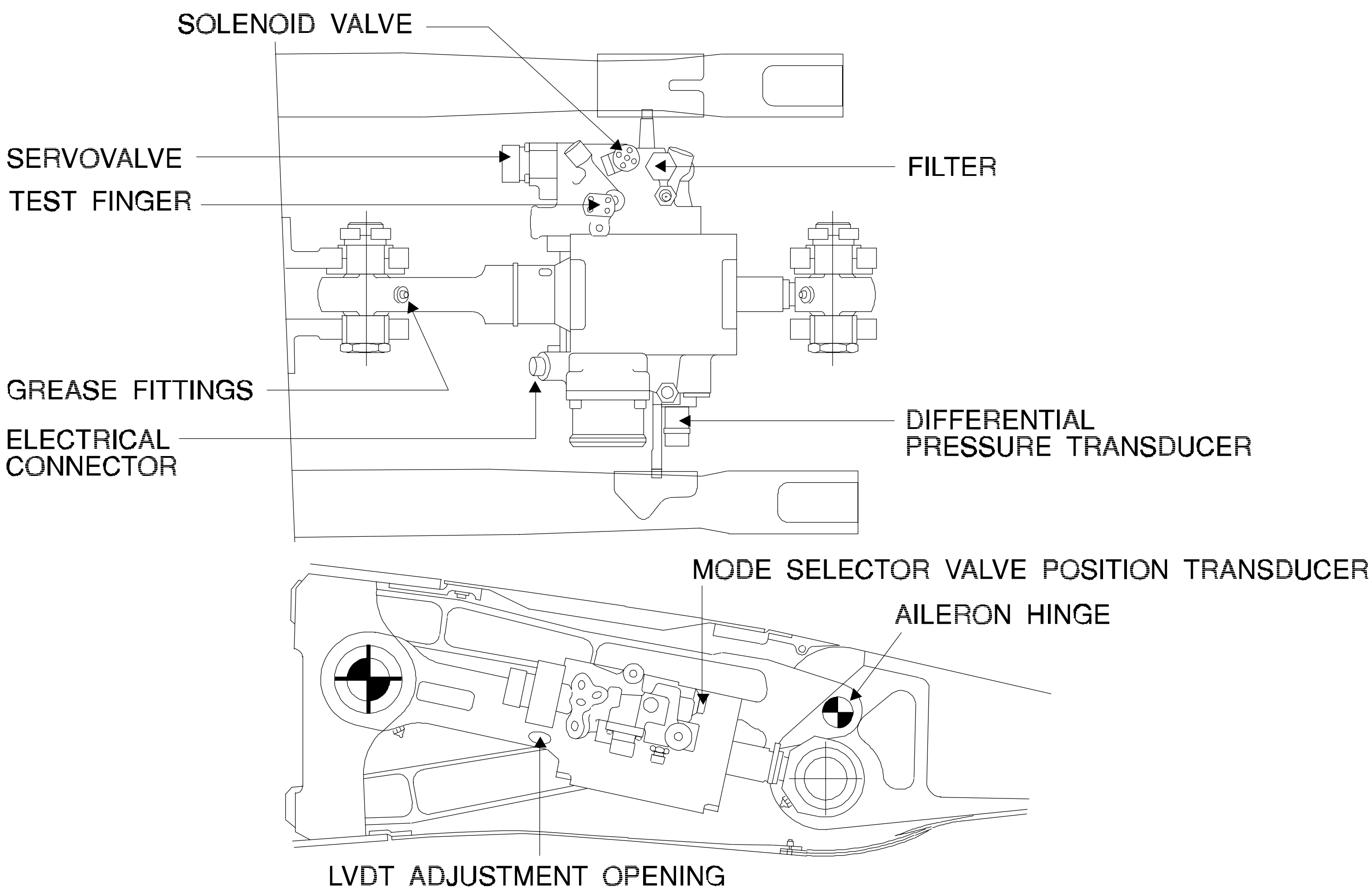
Each aileron is equipped with two identical electrohydraulic fixed body servo controls.

The inboard aileron Servo Controls (SC) and outboard aileron servo control are of similar lay-out but are of a different size.

These servo controls have two modes :

- active,
- damping.

INBOARD SERVO CONTROL



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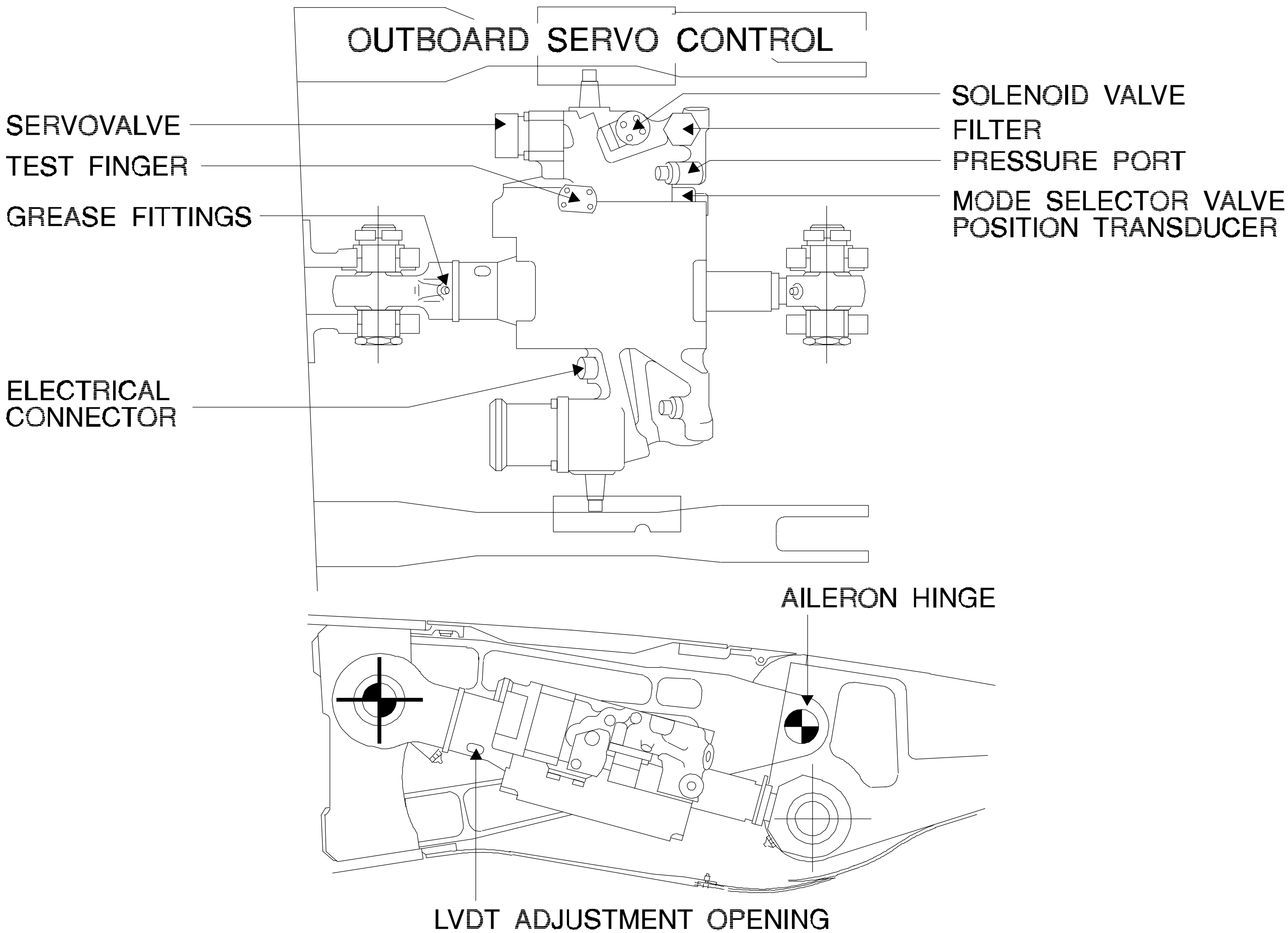

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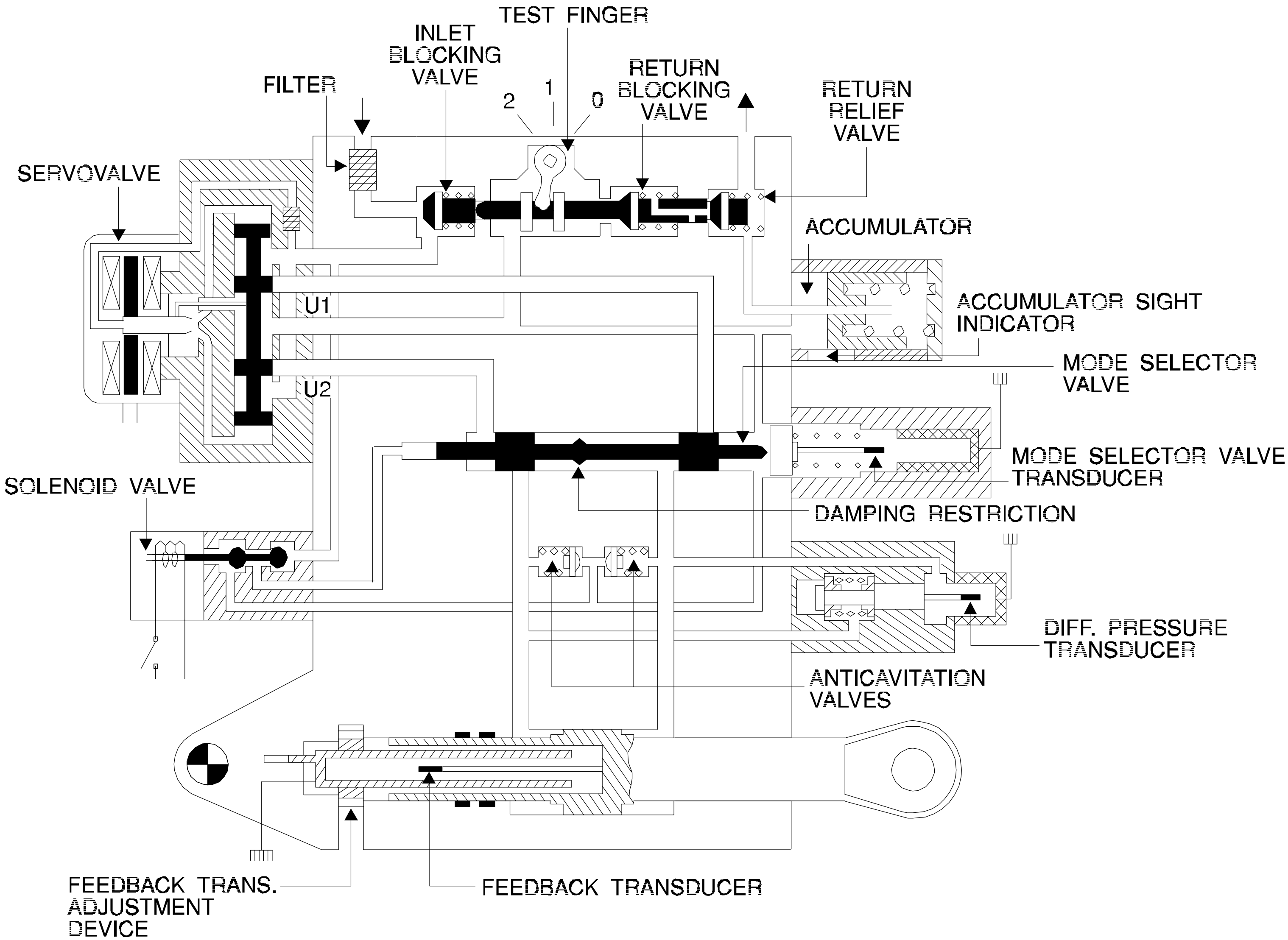

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SERVO CONTROL PRESSURIZATION

The pressurization of the servo control causes the opening of the inlet blocking valve and of the return blocking valve

This involves the supply of the servovalve by the High Pressure system and the connection of the servo control return line to the Low Pressure system.

Inlet blocking valve : High Pressure (HP)

Return blocking valve : Low Pressure (LP)

ACTIVE MODE

In this case, the solenoid valve is energized.
This enables the HP fluid to pass and thus place the mode selector valve in the active position.

The two chambers are thus connected to the user ports of the servovalve (U1 and U2).

The mode selector valve position transducer (LVDT) supplies an electrical signal to the computer which identifies this state.

When the servovalve receives an order, the servovalve jet pipe is deflected. The HP fluid is thus connected to one chamber of the actuator and moves the actuator.

DAMPING MODE

In this configuration, the solenoid valve is de-energized.
The mode selector valve moves under the action of its spring.

The two chambers are thus interconnected through the damping restriction and the anticavitation valves.
The mode selector valve transducer transmits this state to the computers.

The damping mode prevents the appearance of flutter in the event of multiple failures.

HYDRAULIC FAILURE

The inlet and return blocking valves close.
The servo control is then isolated from the aircraft hydraulic system.
The accumulator is permanently connected to the return line of the servovalve.

The return relief valve keeps the pressure in the LP line higher than the pressure in the aircraft return system and permits the accumulator to be filled.

The mode selector valve moves under the action of its spring.
The servo control then operates in the damping mode.

ELECTRICAL FAILURE

In this case, the solenoid valve is de-energized.
The mode selector valve also moves under the action of its spring and the servo control is thus in damping mode.

SAFETY TEST

The servo control design enables the test of the accumulator, blocking valves and return relief valve to be performed using the accumulator sight indicator and the test finger.

The test finger is manually operated by using an hexagon socket wrench.

Position zero (0) :

- check sealing of inlet and return blocking valves and of the return relief valve.

Position "leak check" (1) :

- leak check of inlet blocking valve and return relief valve.

Position "discharge" (2) :

- check of stroke of accumulator piston.

STUDENT NOTES:

AILERON COMPONENTS

Inboard Servo Control
Ouboard Servo Control

SAFETY PRECAUTIONS

WARNING :

PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :
- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING :

MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.

STUDENT NOTES

INBOARD SERVO CONTROL

FIN : 7CS1, 8CS1
7CS2, 8CS2

ZONE : 591, 691

COMPONENT DESCRIPTION

The inboard servo controls are electrically controlled fixed body servo controls.

AFTER REPLACEMENT

After replacement of the servo control, it is necessary to adjust the feedback transducer (LVDT).
It is necessary to get an equal voltage in the secondary winding (electrical zero) when the aileron is in neutral position.
This is done through an action on the feedback transducer adjustment device.

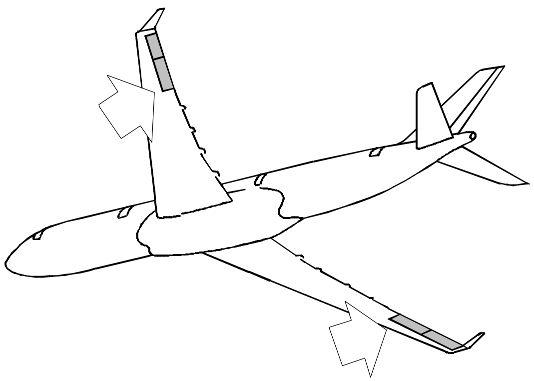
IN SITU TEST

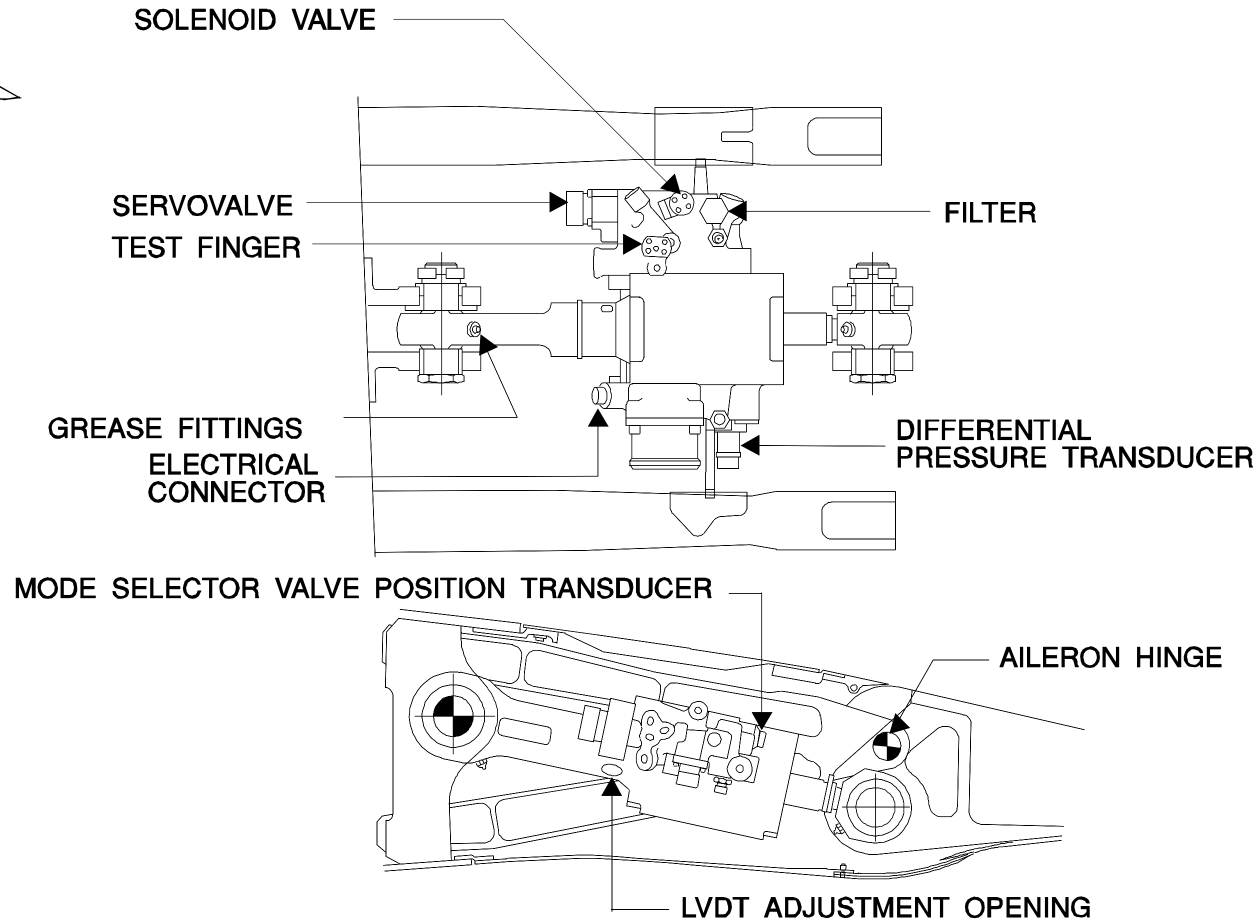
The servo control design enables the test of the accumulator, blocking valves and relief valve to be performed using the accumulator sight indicator and test finger.

LINE REPLACEABLE UNITS

The components below are Line Replaceable Units (LRUs) :

- filter,
- servovalve,
- solenoid valve,
- mode selector valve transducer,
- differential pressure transducer.





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OUTBOARD SERVO CONTROL

FIN : 9CS1, 10CS1
9CS2, 10CS2

ZONE : 592, 692

COMPONENT DESCRIPTION

The outboard servo controls are electrically controlled fixed body servo controls.

AFTER REPLACEMENT

After replacement of the servo control, it is necessary to adjust the feedback transducer (LVDT).
It is necessary to get an equal voltage in the secondary winding (electrical zero) when the aileron is in neutral position.
This is done through an action on the feedback transducer adjustment device.

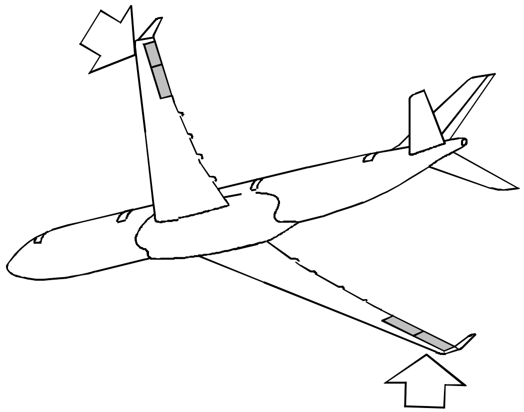
IN SITU TEST

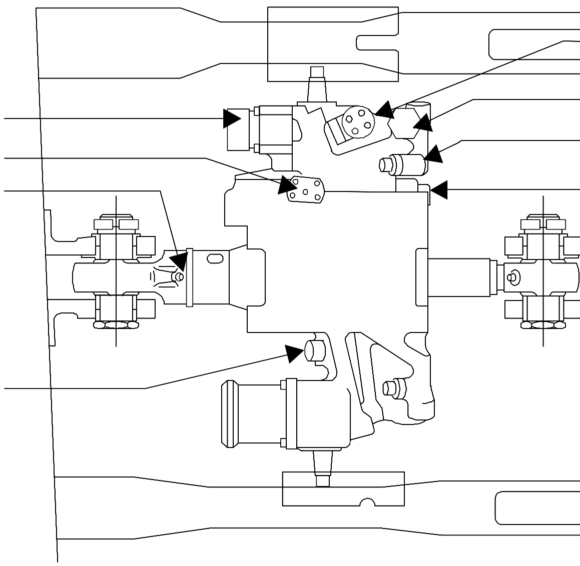
The servo control design enables the test of the accumulator, blocking valves and relief valve to be performed using the accumulator sight indicator and test finger.

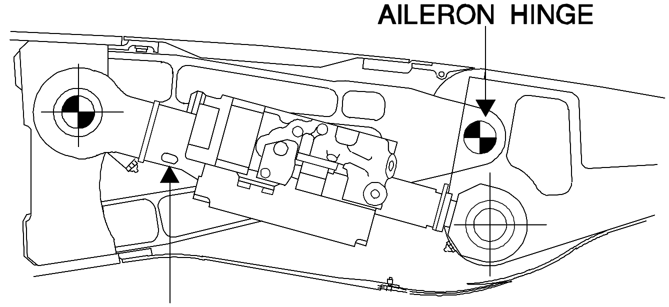
LINE REPLACEABLE UNITS

The components below are Line Replaceable Units (LRUs) :

- filter,
- servovalve,
- solenoid valve,
- mode selector valve transducer,
- differential pressure transducer.







FQW4200 GE Metric

STUDENT NOTES

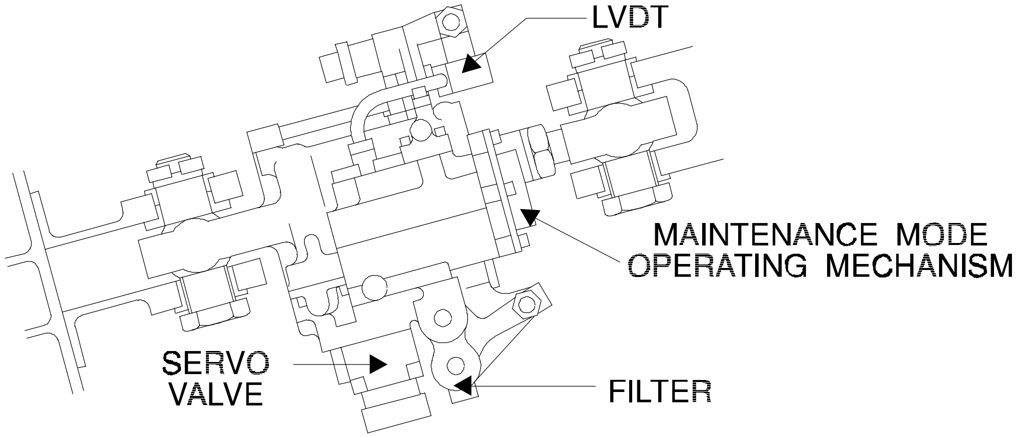
SPOILER SERVO CONTROL DESCRIPTION AND OPERATION

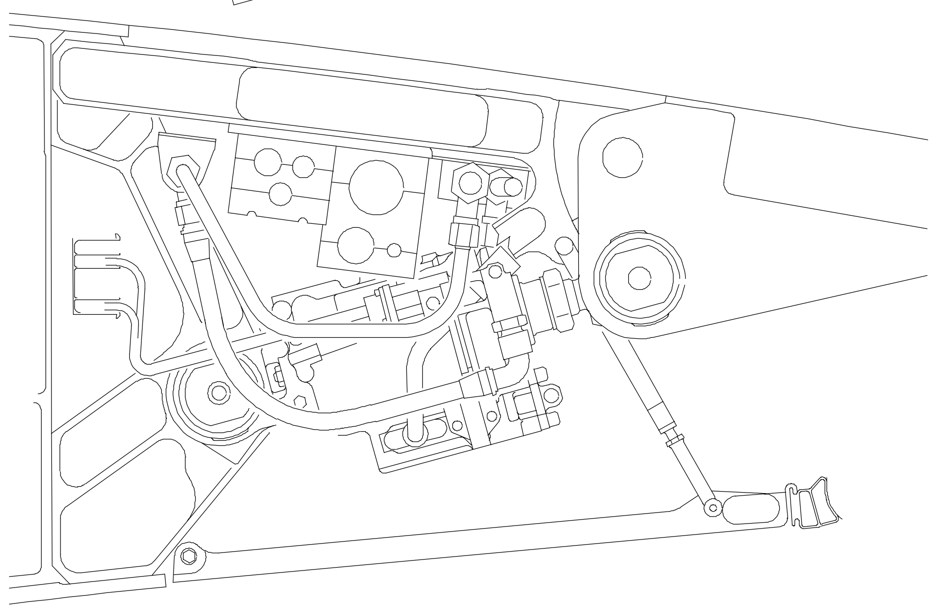
FQW4200 GE Metric

GENERAL

The servo controls are electrohydraulic units.
They are all the same size but have different lengths of travel.

Spoiler 1 has a greater control travel than spoiler 2 thru 6.
The servo controls are of a double acting linear type.





FQW4200 GE Metric

SERVO CONTROL PRESSURIZED

The pressurization of the servo control causes the opening of the inlet check valve.
Hydraulic pressure is applied to the by-pass valve and to the plunger which holds the blocking valve in the open position.

Thus the two actuator chambers are connected to the servo valve control lines.

The servovalve has a biased zero.
When the servo control is not activated, the input signal is equivalent to the electrical zero, its spool valve is open at 20% of its maximum travel.

NORMAL OPERATION

When the servo control receives an extension signal, the servovalve operates to allow hydraulic pressure into the extension side of the actuator piston.
The piston moves to extend the spoiler.

The LVDT sends a signal that represents the position of the spoiler to the associated computer (Flight Control Primary Computer (FCPC) or Flight Control Secondary Computer (FCSC)).

When the servo control receives a spoiler retraction signal, the servovalve permits hydraulic pressure to be supplied to the retraction chamber of the actuator piston.
The piston moves rearwards and retracts the spoiler.

ELECTRICAL FAILURE

If there is a failure of the electrical power to the spoilers, the servovalve input signal is nulled.
The servovalve is biased.

The torque motor of the servovalve connects the hydraulic pressure to the retraction chamber (C2).

The servo control piston returns to the retracted position and it is held in this position. The spoiler is retracted.

HYDRAULIC FAILURE

When the hydraulic pressure decreases, the check valve closes and isolates the servovalve from the hydraulic pressure.

The plunger moves and the blocking valve closes, the by-pass valve moves rearward under spring action, this isolates the piston chambers from the servovalve control lines.

Both chambers of the actuator piston (C1,C2) can be connected if the blocking valve opens (by-pass).

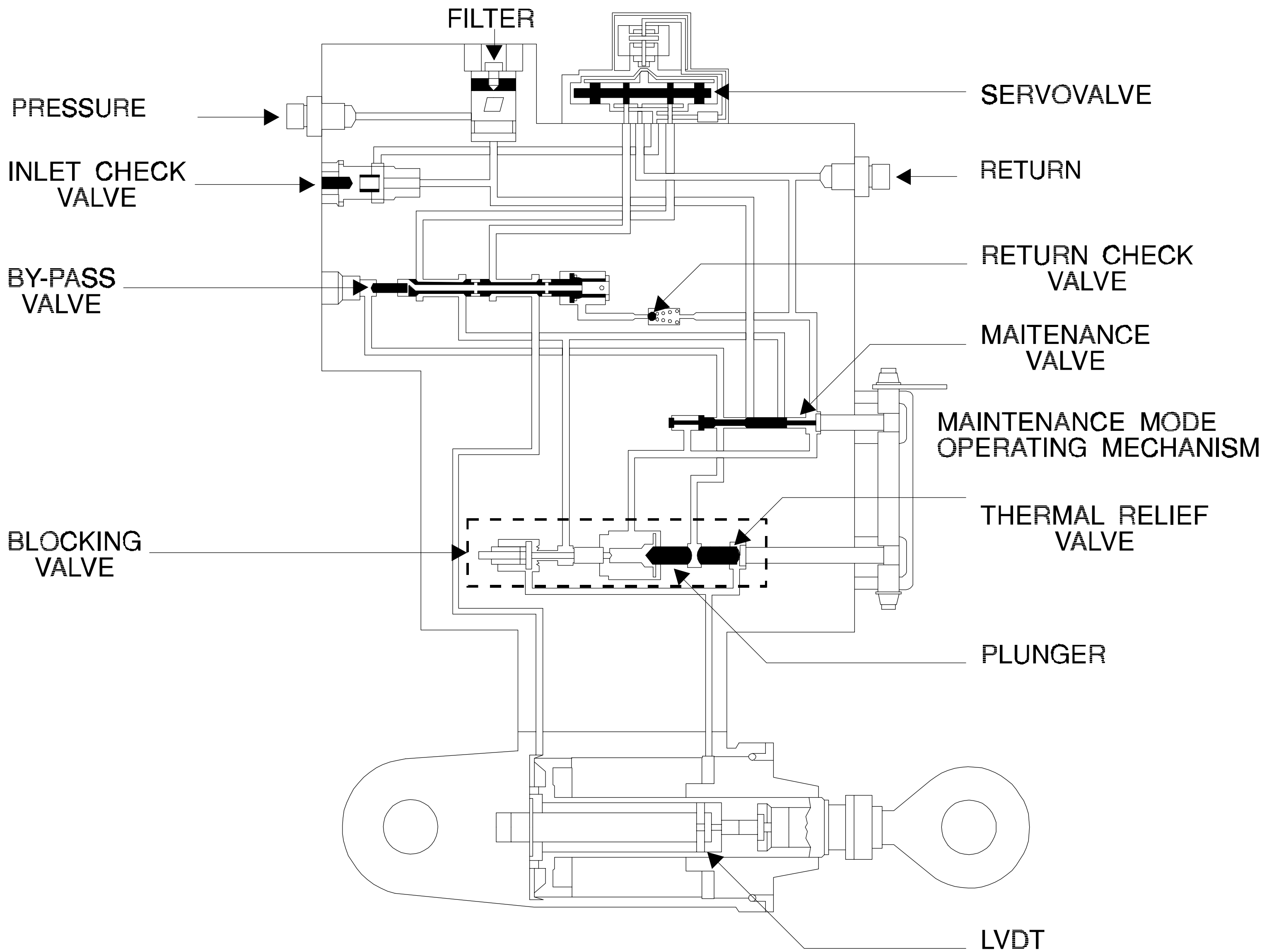
If the spoiler is extended when hydraulic failure occurs, the aerodynamic forces lead to overpressure in chamber one (C1).
The blocking valve opens and both chambers are connected.
The spoiler can be retracted and cannot extend any longer.

MAINTENANCE MODE

In the maintenance mode, you can operate the maintenance lever to unlock the blocking valve.

When you move the maintenance lever, it also operates the maintenance valve which isolates the control chamber of the by-pass valve from the hydraulic power.

Thus the spoiler cannot operate if hydraulic power is let into the servo control, but the spoiler can be operated manually (by-pass).



FQW4200 GE Metric

STUDENT NOTES:

SPOILER COMPONENTS

Servo Controls
Servovalves

SAFETY PRECAUTIONS.

WARNING : PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :

- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING : MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING : MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING : MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.

STUDENT NOTE

SERVO CONTROLS

FIN : 13CS1, 13CS2, 14CS1,
14CS2, 15CS1, 15CS2,
16CS1, 16CS2, 17CS1,
17CS2, 18CS1, 18CS2.

ZONE : 582, 682, 584, 684, 585,
685, 586, 686, 587, 687,
588, 688.

COMPONENT DESCRIPTION

The servocontrols are of a double acting linear type. They have two eye ends, one of which is installed on the wing structure, the other is installed on the spoiler.
They are equipped with an LVDT and a single electrical connector for both the servovalve and the LVDT.

AFTER REPLACEMENT

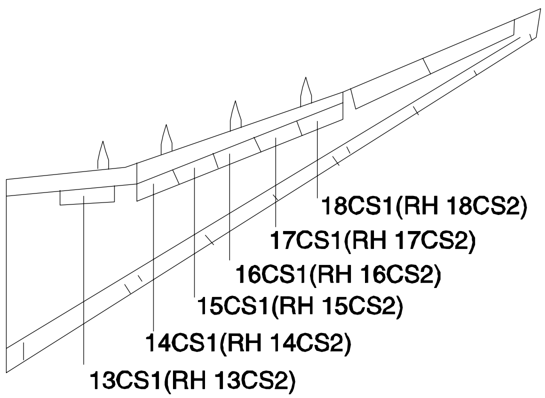
After replacement of the servo control, it is necessary to adjust the actuator rod length.

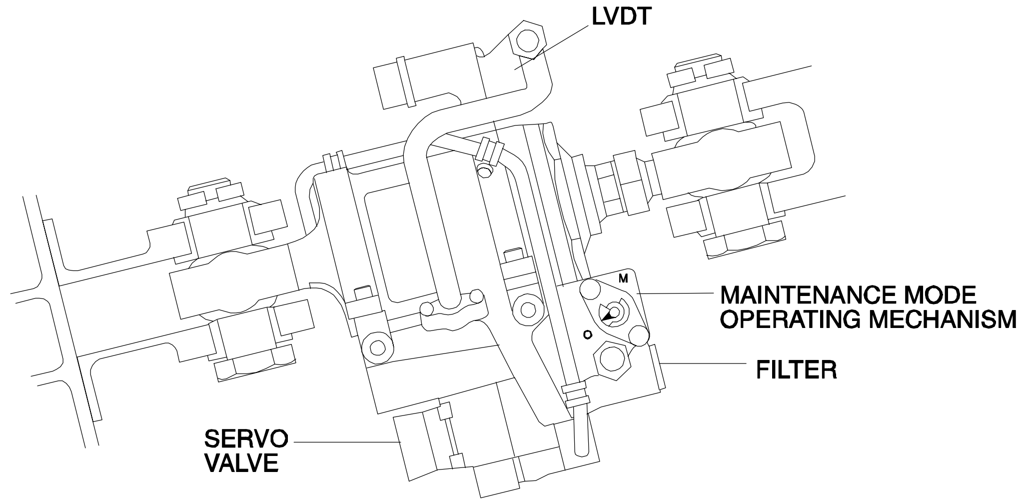
MAINTENANCE PRACTICES

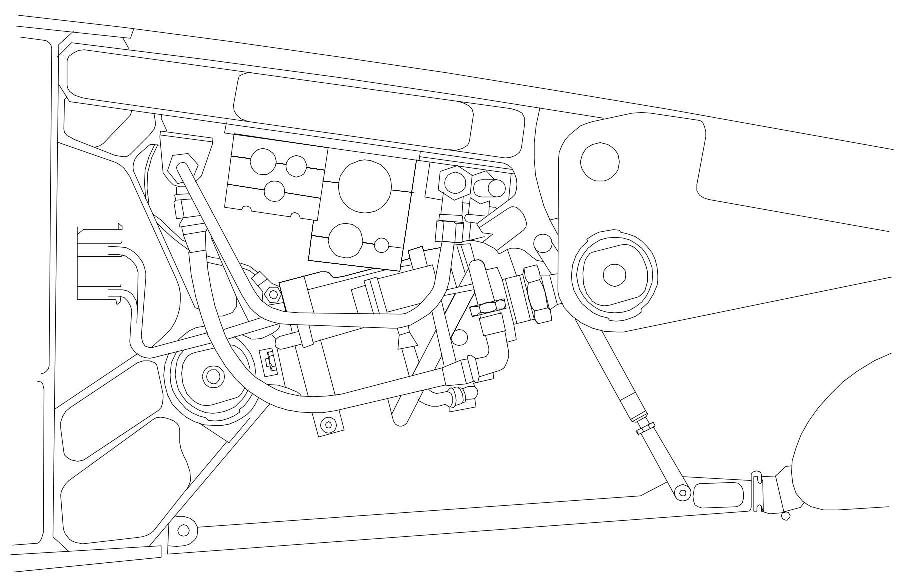
There is a manual override on each servo control. A maintenance lever permits the blocking valve to be unlocked and the maintenance valve to be operated.

LINE REPLACEABLE UNIT (LRU)

The components below are Line Replaceable Units LRUs :
- filter,
- servovalve,


18CS1(RH 18CS2)
17CS1(RH 17CS2)
16CS1(RH 16CS2)
15CS1(RH 15CS2)
14CS1(RH 14CS2)
13CS1(RH 13CS2)

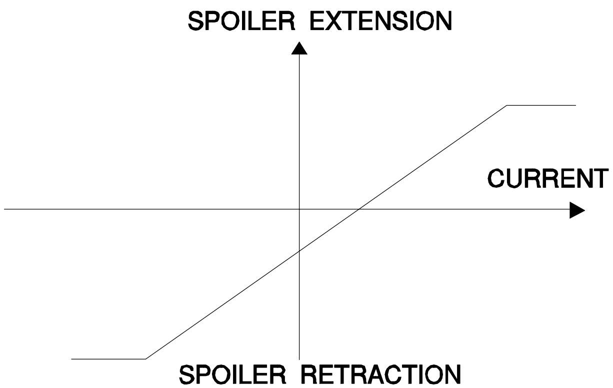

LVDT
M
MAINTENANCE MODE
OPERATING MECHANISM
O
FILTER
SERVO
VALVE



SERVOVALVES

COMPONENT DESCRIPTION

The spoiler servovalves are biased servovalves.



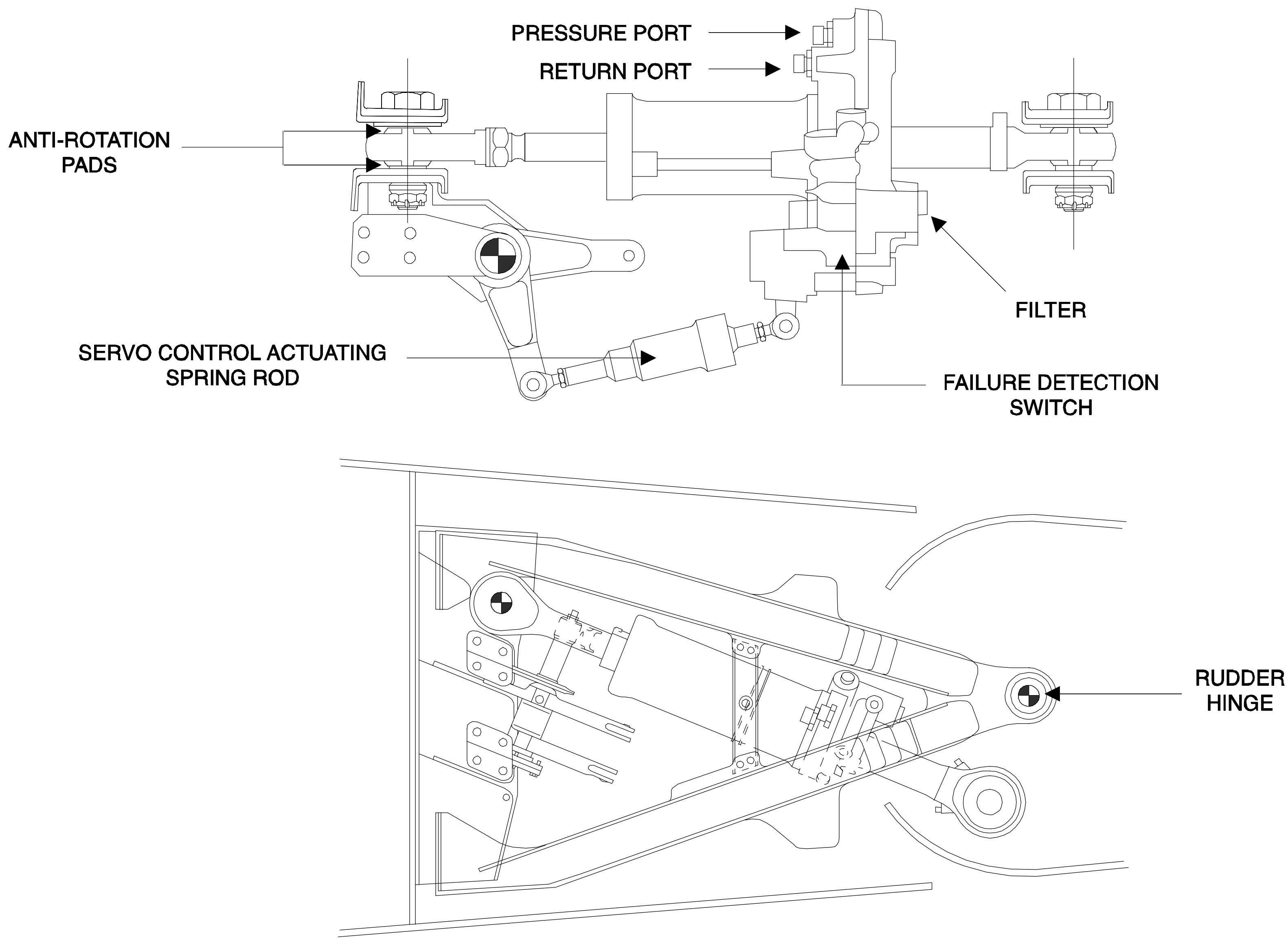
RUDDER SERVO CONTROL DESCRIPTION AND OPERATION

GENERAL

The rudder is actuated by three identical moving-body servo controls which operate simultaneously.

Each servo control has three operating modes :

- active,
- forced,
- depressurized.



FQW4200 GE Metric

SERVO CONTROL PRESSURIZATION

The pressurization of the servo control causes the check valve to open. The fluid flows through the check valve and the heating orifice.

Pressure is applied to the control valve and the pressure relief valve.

ACTIVE MODE

The control valve moves according to the order given to the input lever. The travel of the input lever is limited by the stops.

The fluid flows in one of the two actuator chambers and moves the servo control body.

The body movement resets the control valve in neutral position.

FORCED MODE

In the event of control valve jamming or disconnection of the input lever, the servo control is overriden by the two valid servo controls which drive it through the rudder.

An overpressure is created in one of the two actuating chambers.

The threshold of the spring box is exceeded and an overpressure opens the pressure relief valve. The two actuating chambers are now connected.

The displacement of the pressure relief valve activates the failure detection switch. The information is sent to the FCDCs.

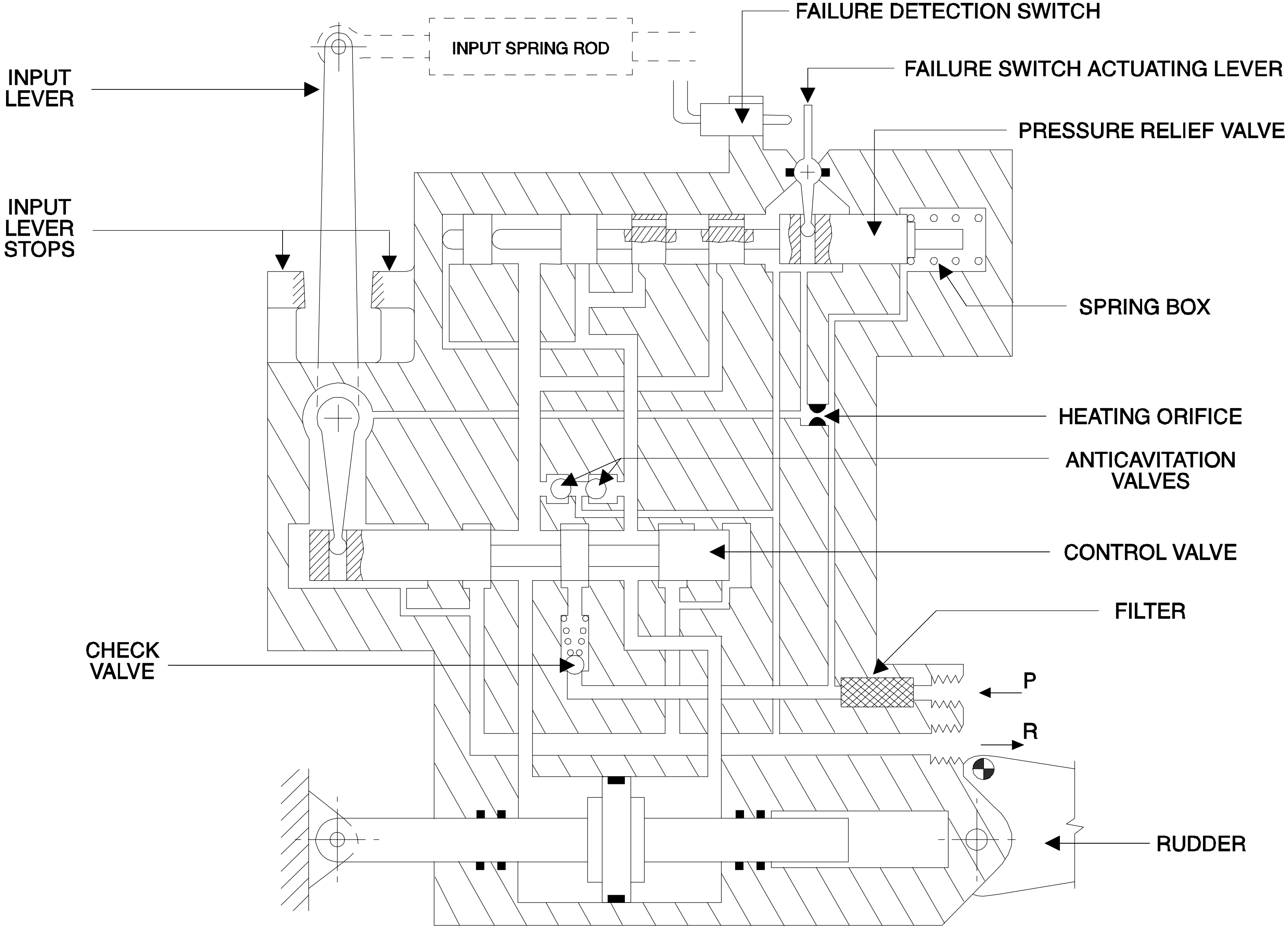
DEPRESSURIZATION MODE

In the absence of hydraulic pressure, the servo control is by-passed. The check valve remains closed and is no longer supplied.

In case of movement of the servo control body due to rudder deflection the pressure relief valve opens.

In order to avoid cavitation due to a lack of pressure, anticavitation valves are installed between the two actuator chambers and the return.

The fluid flows from one actuator chamber to the other. The rudder is then damped.



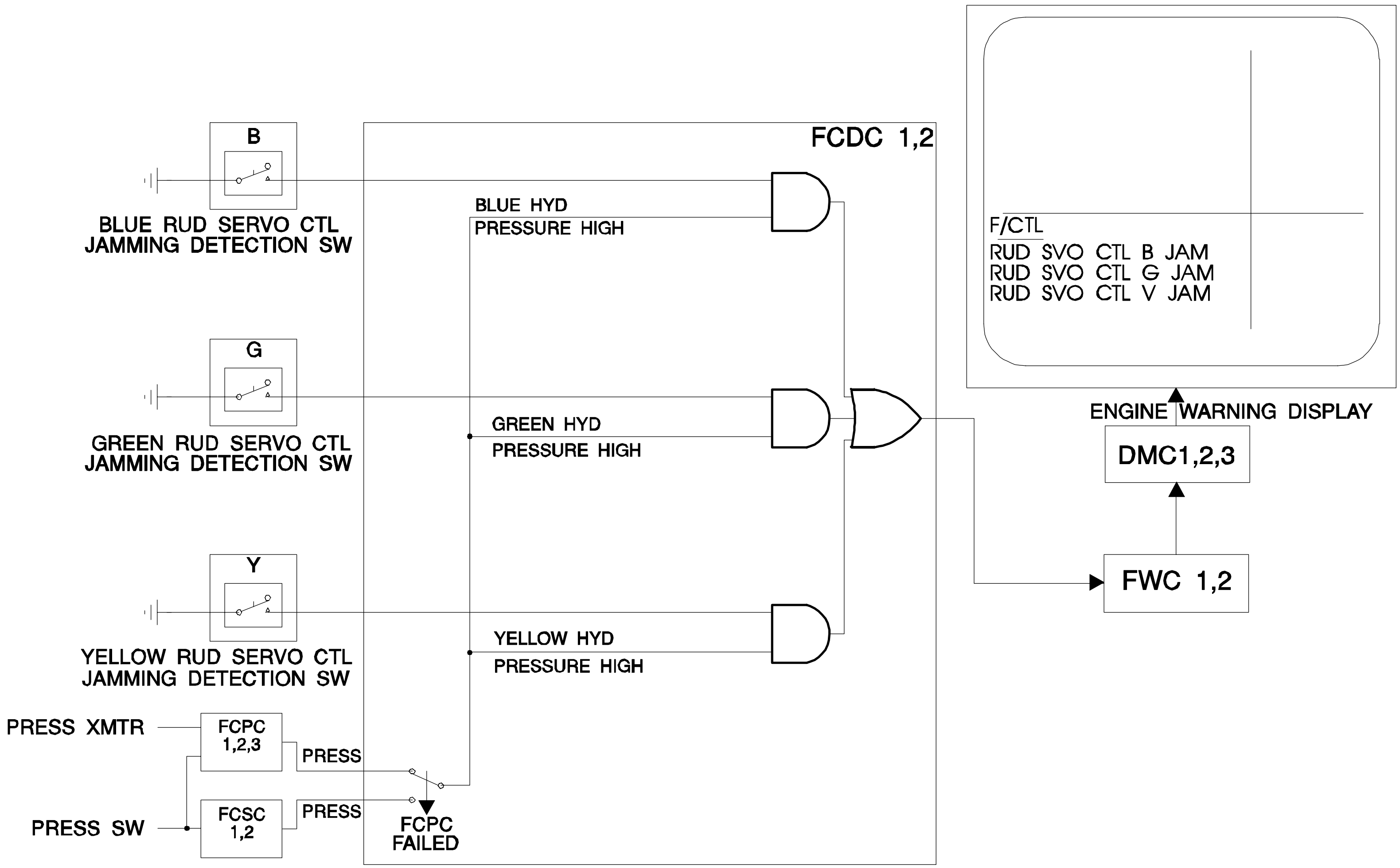
FQW4200 GE Metric

SAFETY TEST

The servo control is designed so as to allow failure detection.

When the servo control is depressurized, the failure switch actuating lever limits the travel of the control valve. This simulates its failure.

An action on the input lever checks the operation of the spring rod and the failure detection switch.
If a failure is detected, the information is transmitted to the engine warning display via the FCDCs, the FWCs and to the DMCs.
(Message RUD SVO CTL B (G or Y) JAM)



FQW4200 GE Metric

STUDENT NOTES:

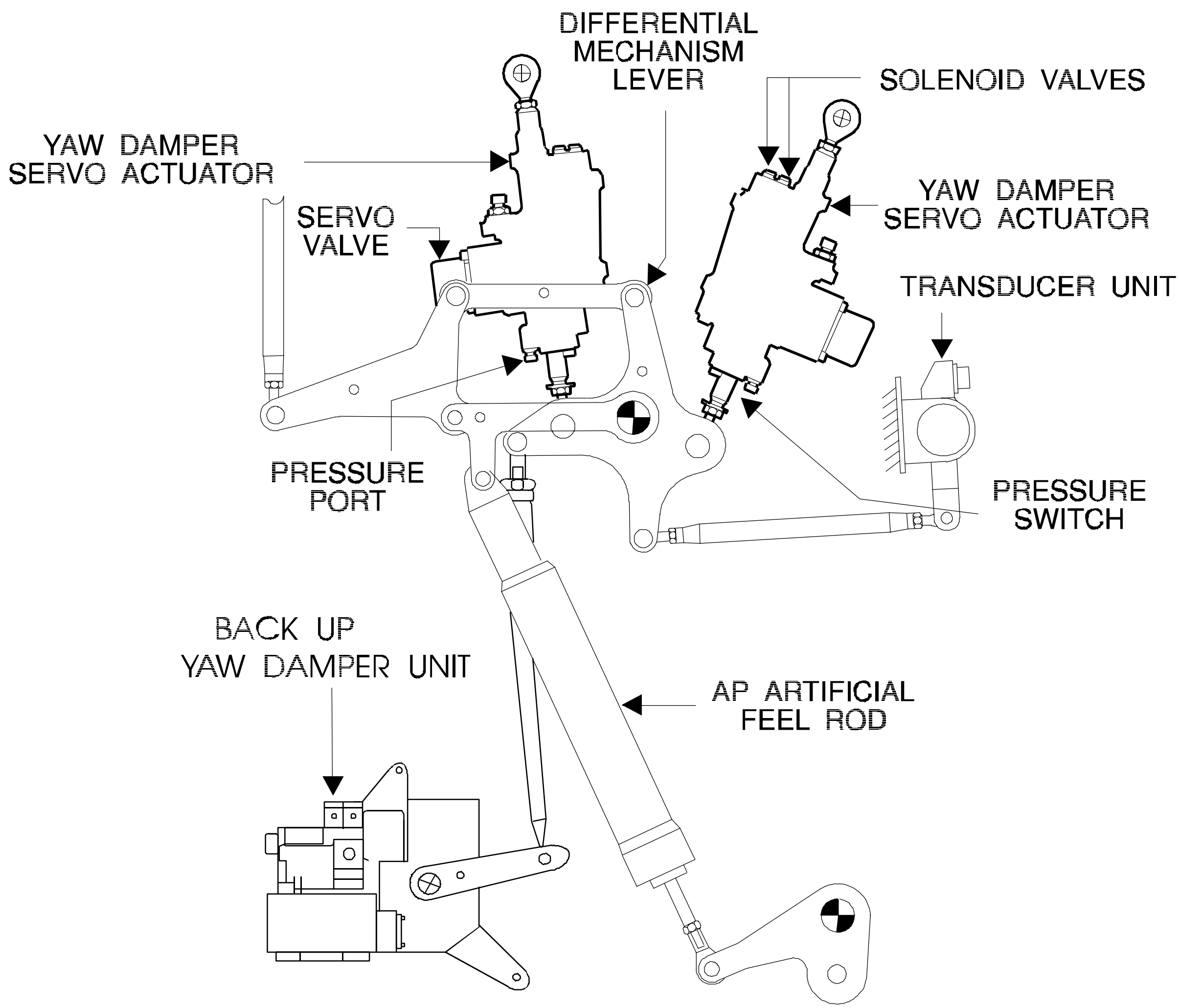
YAW DAMPER SERVO ACTUATOR DESCRIPTION AND OPERATION

GENERAL

The lever of the differential mechanism is connected to the two identical yaw damper servo actuators, to the position transducer unit and to the Back-up Yaw Damper Unit (BYDU).

The yaw damper servo actuators have two modes :

- active,
- by-pass.



FQW4200 GE Metric

SERVO ACTUATOR PRESSURIZATION

The pressurization of the servo actuator causes the servo valve to be directly supplied by the high pressure (HP) system.

ACTIVE MODE

The two solenoid valves are energized to place the two mode selector valves in the active position.
The two actuator chambers are thus connected to the user ports of the servo valves.

The pressure switch, connected to the return pressure, is not activated. The feedback transducer (LVDT) supplies the servoloop feedback information.

When the servovalve receives an electrical order, its jet pipe is deflected. The High Pressure (HP) flow passes into one chamber and moves the actuator.

BY-PASS MODE

In this configuration, the two solenoid valves are de-energized.
The mode selector valves move under the action of their spring.
This causes the interconnection of the two actuator chambers.

The pressure switch, connected to the return pressure, is not activated.

HYDRAULIC FAILURE

In the absence of hydraulic pressure, the two mode selector valves move under the action of their spring.

In this case, the actuator operates in BY-PASS mode.
The pressure switch is not activated.

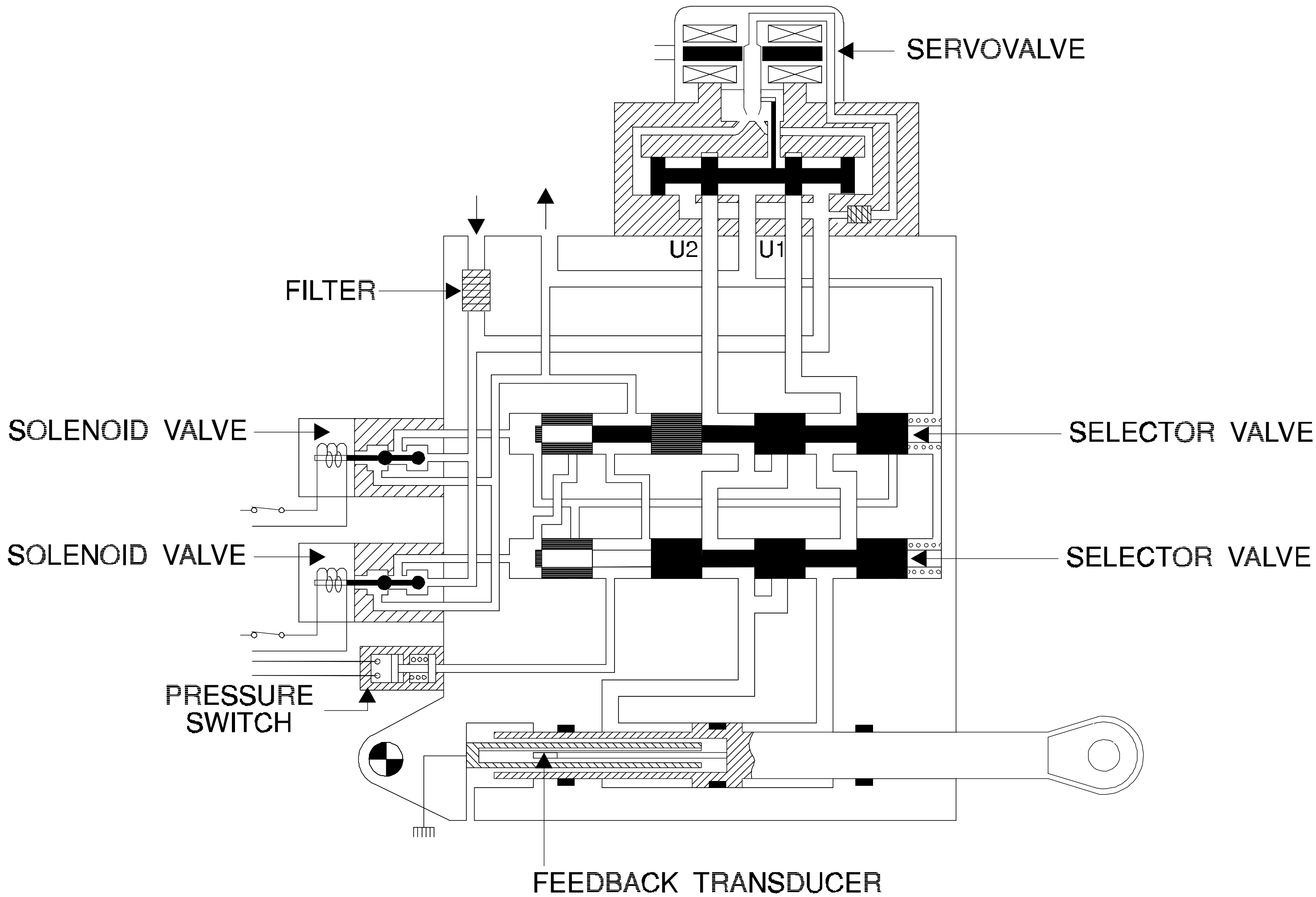
SOLENOID VALVE FAILURE

If one of the mode selector valves is in by-pass mode, while the other is in active mode position, the interconnection of the two actuator chambers is achieved and the actuator is in by-pass mode.

The pressure switch, then connected to the supply pressure (HP), is activated and indicates an abnormal configuration to the computers.

MONITORING

Constant monitoring: the disagreement between the selector valves position is detected by a pressure switch.



FQW4200 GE Metric

STUDENT NOTES:

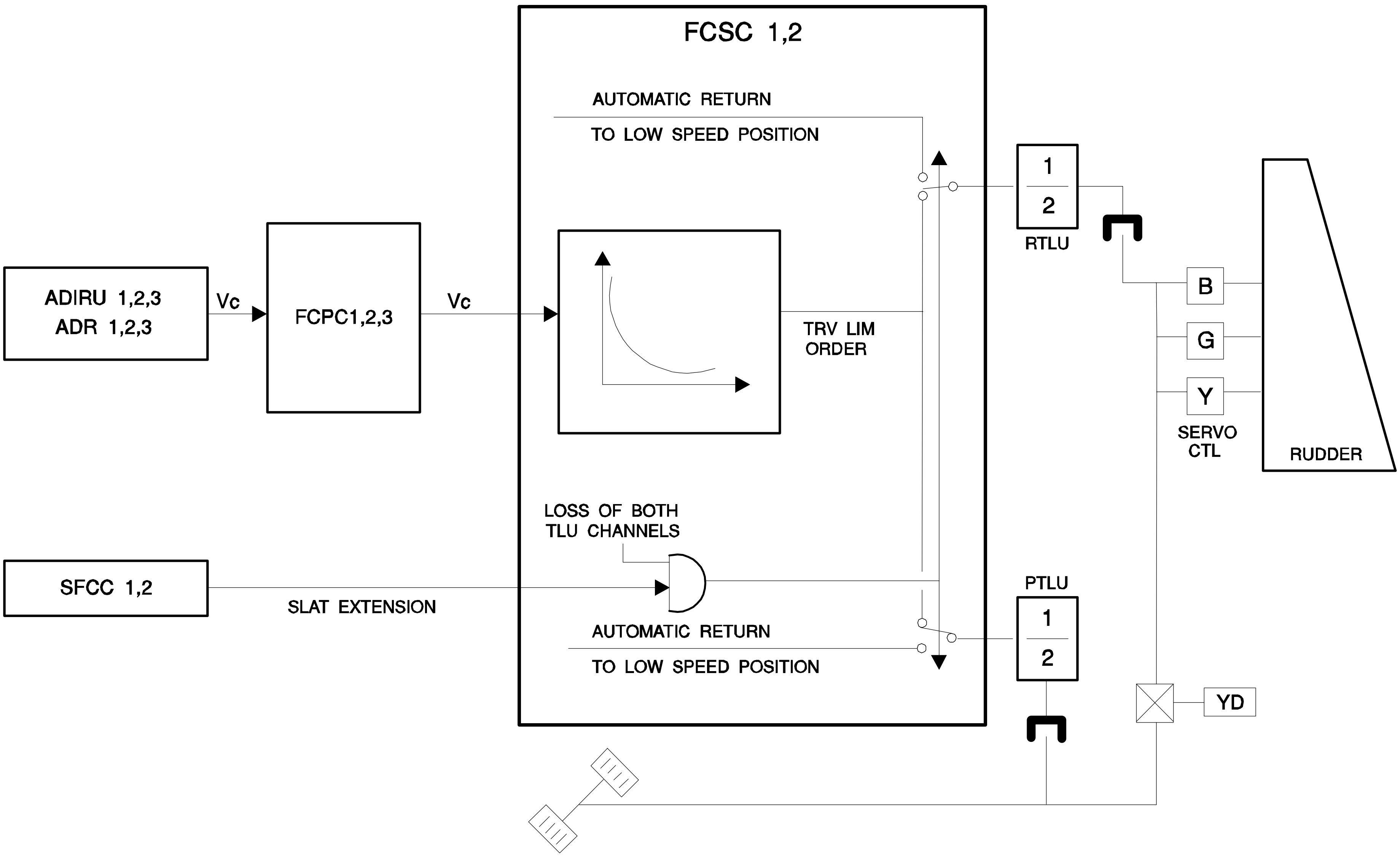
RUDDER AND PEDAL LIMITER DESCRIPTION AND OPERATION

GENERAL

Two Travel Limitation Units (TLUs) are installed on the rudder system.
- one Rudder TLU (RTLU) is fitted to limit the deflection of the rudder
- one Pedal TLU (PTLU) is installed to limit the deflection of the pedals in order to reduce the load on the rudder mechanical channel.

Each TLU consists of:
- a duplicated mechanical assembly with a redundant connection to the rudder control linkage
- two independent electrical assemblies connected to FCSC 1 and 2.

In the event of failure of both Flight Control Secondary Computers (FCSCs), an independent standby control permits full authority of the pedals and rudder to be regained at slat extension.



FQW4200 GE Metric

NORMAL OPERATION

Only one of the servoloops is in the active mode, the other one is in standby. In the event of an excessive rudder control order transmitted by the linkage, the two rings, linked by the external levers, come into contact with the locking cross bars, thus limiting the control travel.

In active mode the energized motor is driven according to the command orders.
One of the RVDTs (Rotary Variable Differential Transducers), connected to the active motor, gives the position feedback data depending on the locking cross bar position.
Servoing monitoring is ensured by one of the RVDTs driven by the other locking bar.

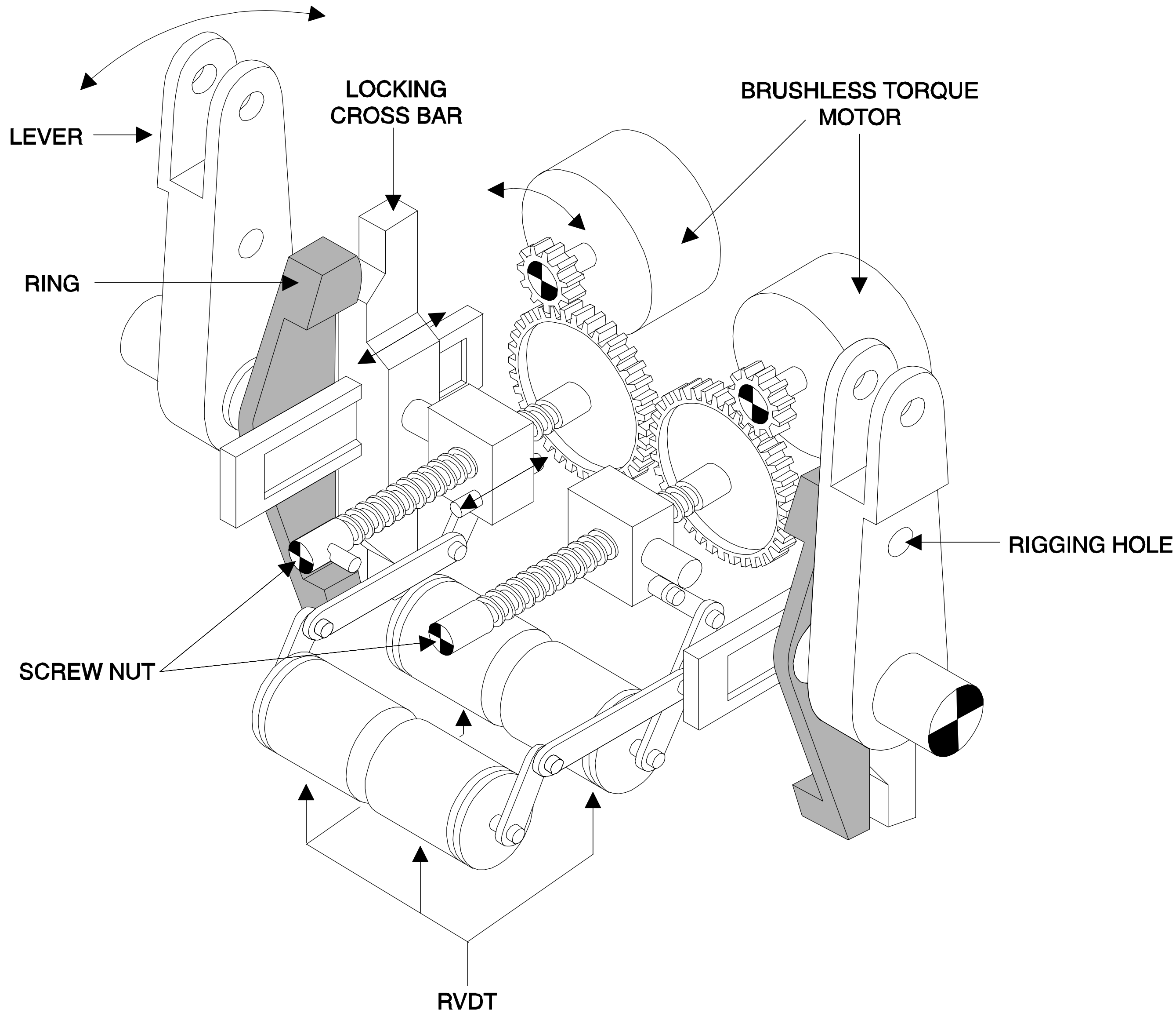
In standby mode, the electronic circuits are not energized and the associated motor is driven by the active motor through a gear.

FAILURE OF FLIGHT CONTROL SECONDARY COMPUTER (FCSCs) 1 AND 2

In the event of failure of the rudder travel limitation function in each FCSC, the electronic circuits and the relays of both assemblies are not energized.
The locking cross bars keep their positions throughout the flight.

When the slats are extended, the standby control relays are energized, thus supplying the motor in the direction which sends the locking cross bars in their full surface authority stops.

After a certain period of time, the electronic relay is de-energized and the locking cross bars keep their previously stated positions.



FQW4200 GE Metric

STUDENT NOTES:

BACK-UP YAW DAMPER UNIT DESCRIPTION/OPERATION

GENERAL

The Back-up Yaw Damper Unit (BYDU) is an electromechanical unit associated with two standby electrical generators driven by hydraulic power sources. The unit operation is controlled and monitored by an electronic control assembly.
The BYDU provides the dutch roll damping when the flight control computers disengage following :
- computer failures
- hydraulic failures.

DESCRIPTION

The BYDU is mechanically connected in parallel with two yaw damper servo actuators.
The BYDU consists of four main subassemblies:
- one electromechanical actuator,
- two hydraulically powered electrical generators,
- one electronic unit connected to a rate gyrometer and a position transducer.

OPERATION

The BYDU has two operating modes.

STAND-BY MODE:

In normal operation, the BYDU is in the stand-by mode.
At least one winding of each solenoid is energized (solenoid valves closed).
The output lever of the BYDU is driven by the active yaw damper servo actuator, the required transparency being achieved by the pre-loaded spring device internal to the unit.

ACTIVE MODE:

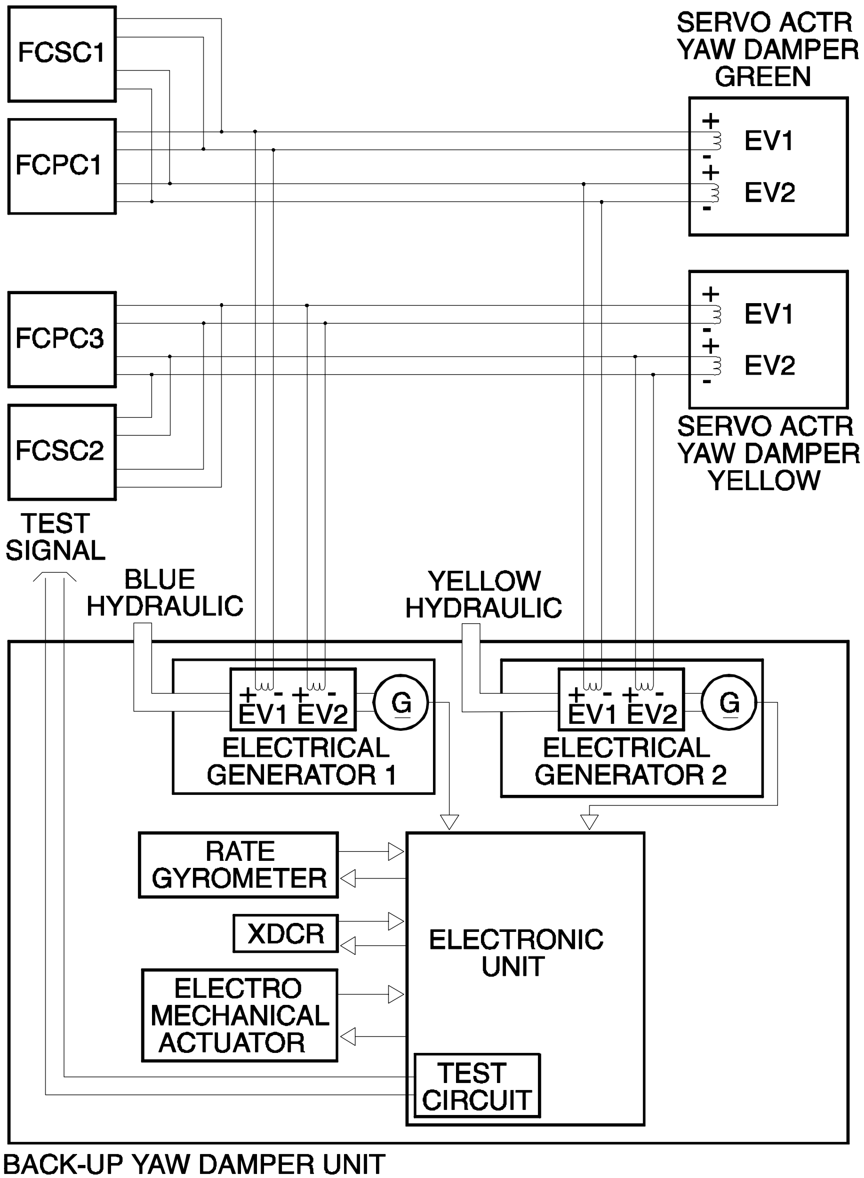
When the two yaw damper servo actuators are unserviceable, the BYDU switches to the active mode.
One generator solenoid valve, at least, is de-energized (both solenoid valve windings de-energized). The electrical generators provide the electrical power required for operation.
The BYDU measures the yaw rate of the aircraft and drives the rudder control with the electromechanical actuator, through the pre-loaded spring device which now acts as a rigid element.

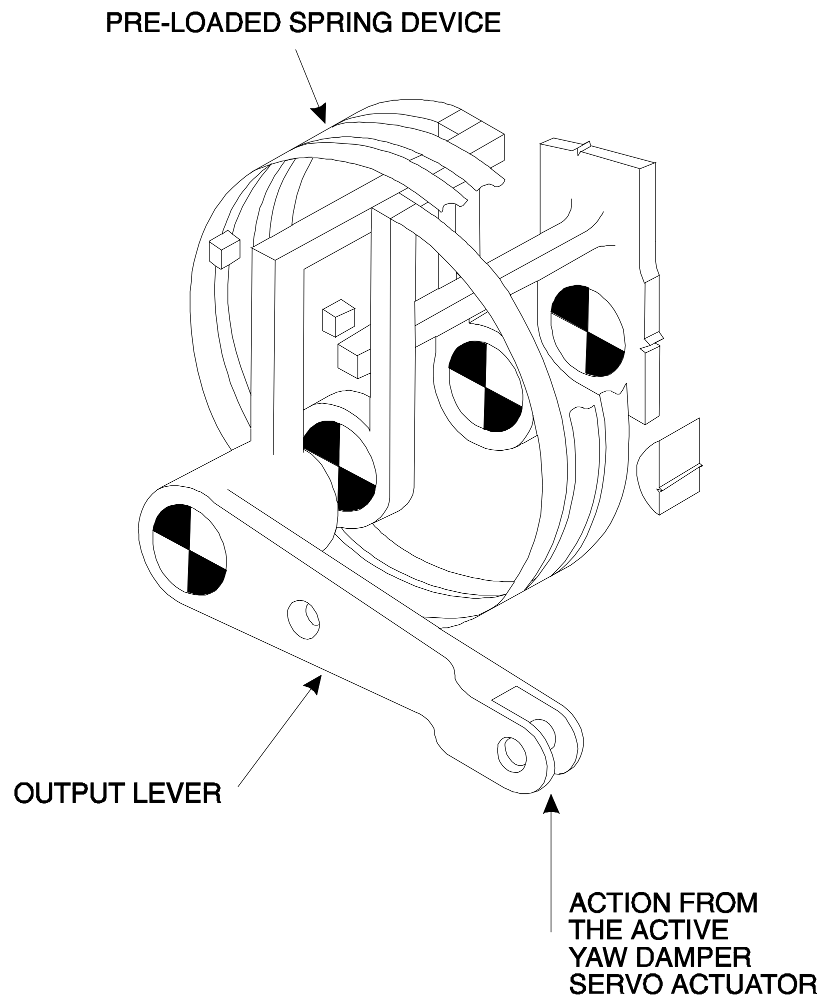
FAILURES

In the event of a solenoid valve failure, an electrical generator failure or a hydraulic failure, the other electrical generator provides the different modes of operation.

TEST

An automatic test controlled by the Flight Control Data Concentrator (FCDC) checks the operation of the complete unit via the MCDU.





FQW4200 GE Metric

STUDENT NOTES:

RUDDER TRIM ACTUATOR DESCRIPTION AND OPERATION

GENERAL

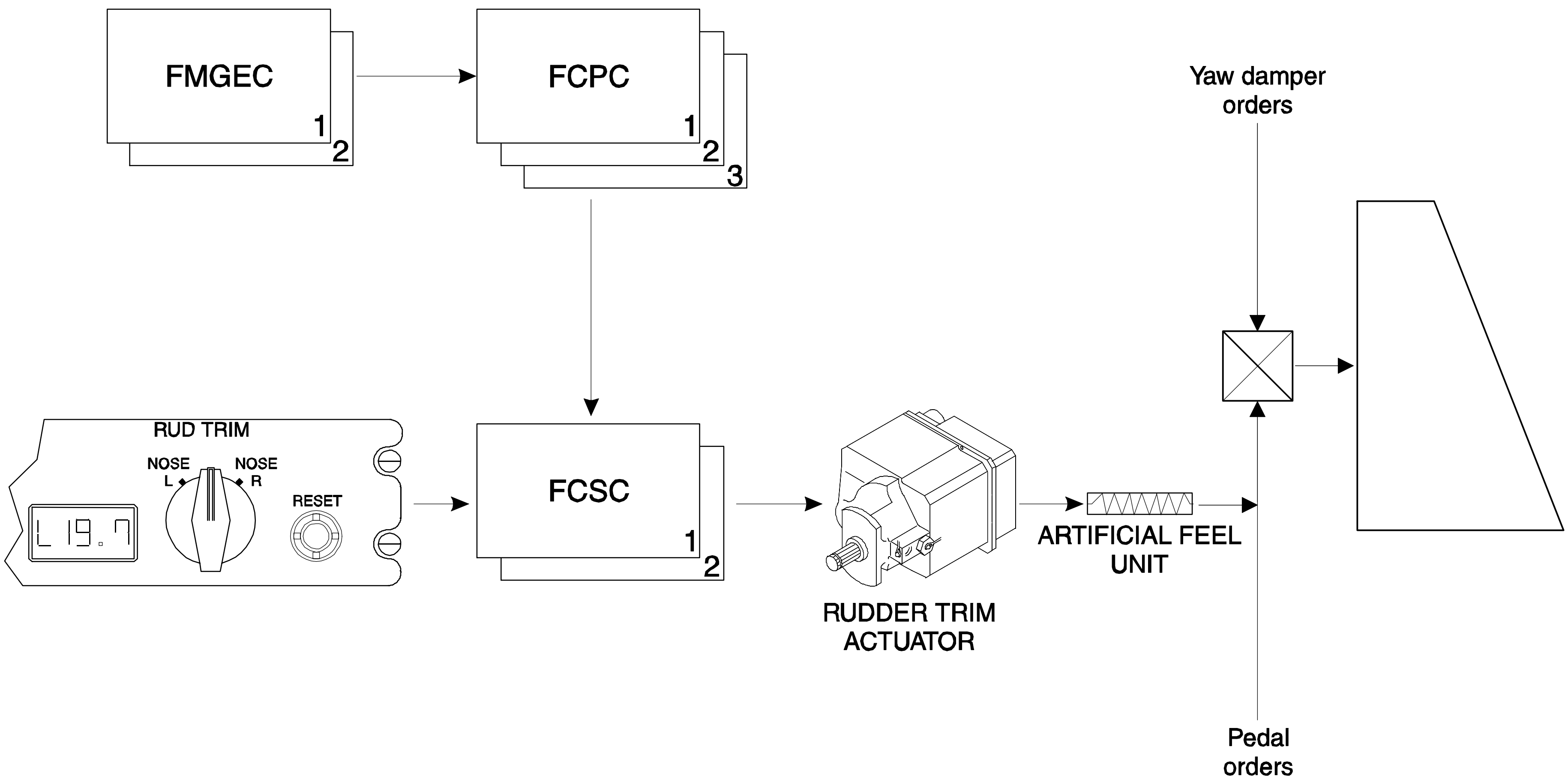
One Rudder Trim Actuator (RTA) is installed on the rudder system.

The RTA (Rudder Trim Actuator) is one of the mechanical inputs of the rudder servo-controls.
It enables the zero force position of the artificial feel mechanism to be adjusted.

CONTROLS

The RTA is an electromechanical item which converts an electrical input from the FCSCs into a rotation of its output shaft.

The RTA can be controlled in manual and in AutoPilot (AP) mode. In both cases, orders are sent via the FCSCs.
In manual mode, the pilots directly control the RTA through the rudder trim rotary switch located on the center pedestal.
In AP mode, the FMGECs elaborate the RTA order which is sent to the FCSCs through the FCPCs.



FQW4200 GE Metric

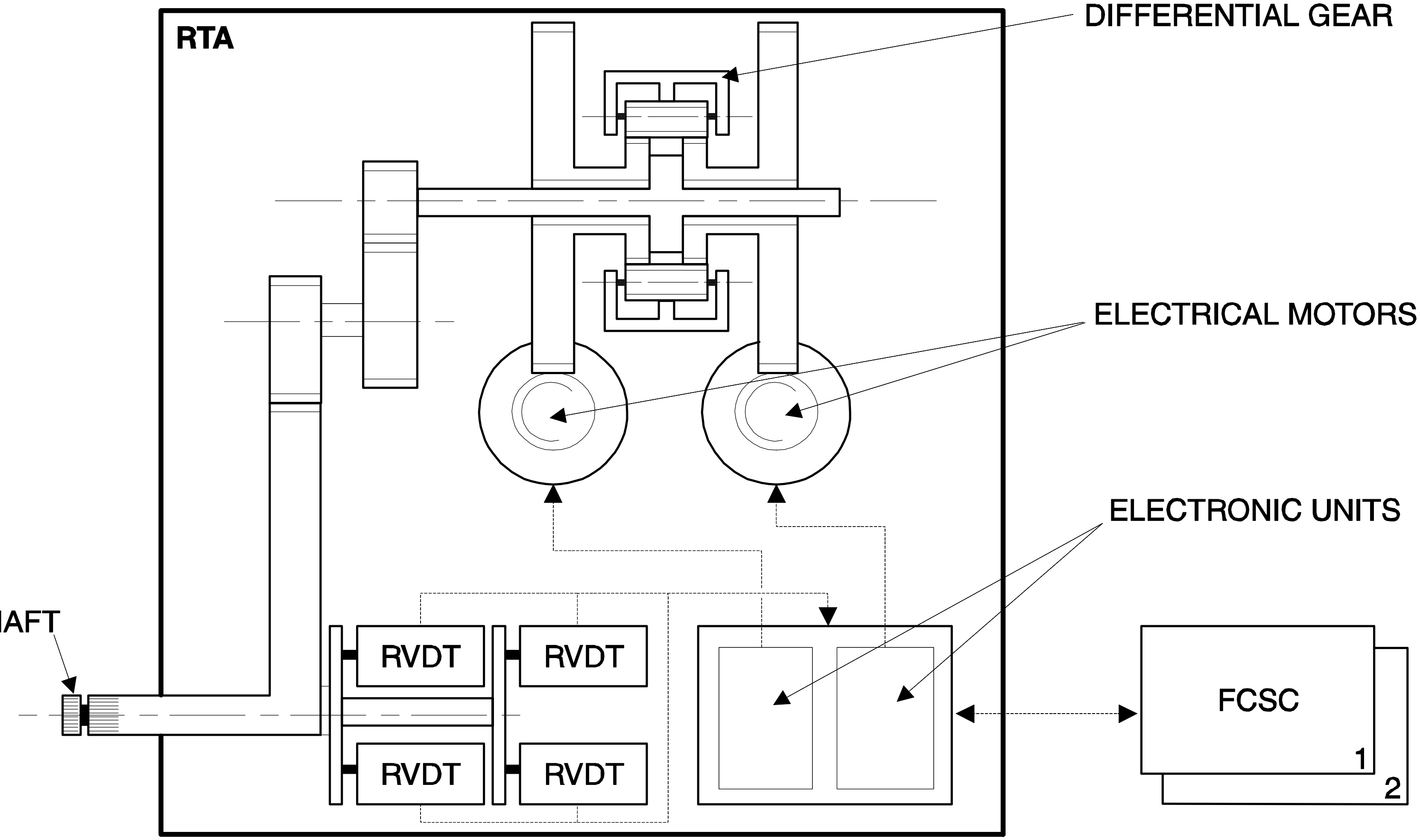
DESCRIPTION

The RTA comprises two brushless DC motors.
Each motor is controlled by its associated electronic unit.
The motors drive the output shaft through a differential gear box.
Four RVDTs transmit the output shaft position feedback signal to the FCSCs.

OPERATION

In normal operation one motor is active, the other one in standby.

The active motor is controlled by its electronic unit according to the control order given by the FCSCs.



FQW4200 GE Metric

STUDENT NOTES:

RUDDER COMPONENTS (FORWARD)

Rack Assembly
Tention Regulator

SAFETY PRECAUTIONS

WARNING :

PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :

- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING :

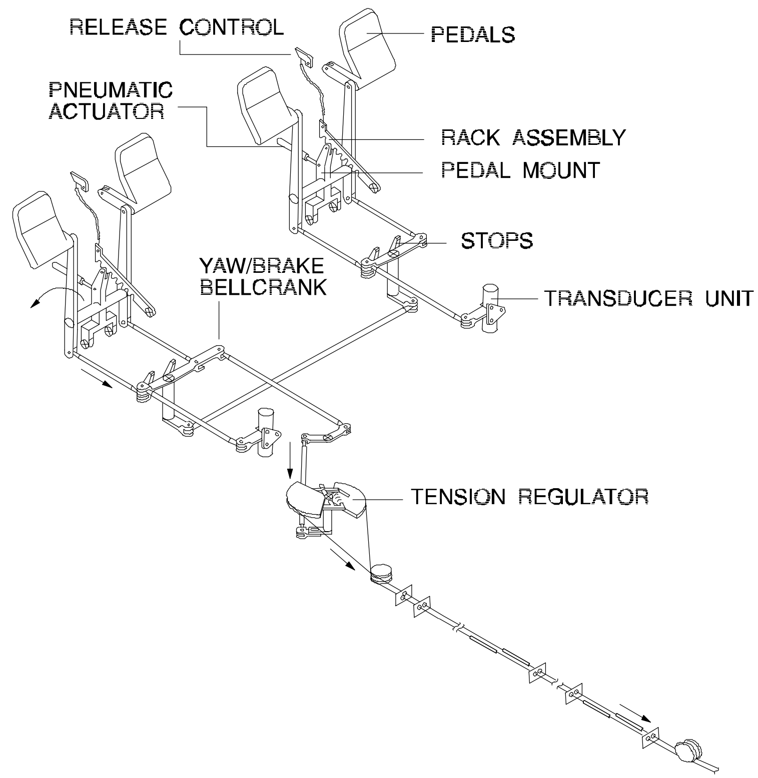
MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURISE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.


RELEASE CONTROL
PEDALS
PNEUMATIC ACTUATOR
RACK ASSEMBLY
PEDAL MOUNT
STOPS
YAW/BRAKE BELLCRANK
TRANSDUCER UNIT
TENSION REGULATOR

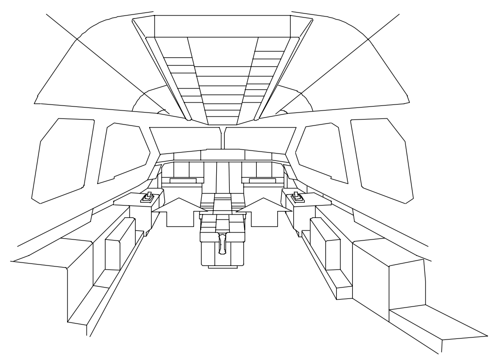
RACK ASSEMBLY

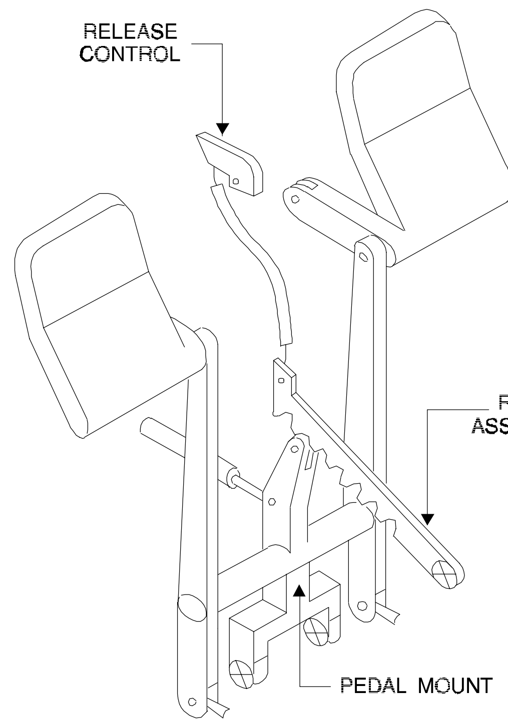
COMPONENT DESCRIPTION

The Captain and First Officer's pedal assemblies are partly identical and include a frame on which are installed :

- the pedals and interconnecting mechanism for the pedal arms which also include the stops,
- the adjustment device comprising the pedal mount.

The pedal mount is hinged onto the frame at its lower section, pushed backwards by the pneumatic actuator and held by the rack.
The release control operates the rack.
The graduated scale of the indicator displays the adjustment position.





FQW4200 GE Metric

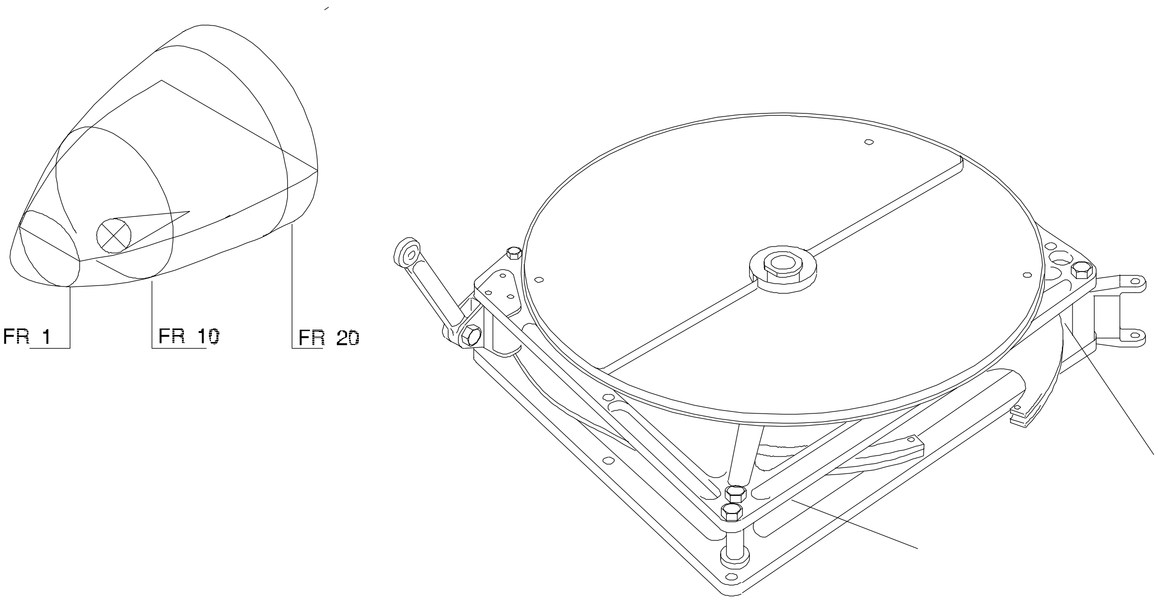
TENSION REGULATOR

FIN : 5001CY

ZONE : 121

COMPONENT DESCRIPTION

The cable tension regulator absorbs the relative length variations 1of the cables with respect to the structure, due to thermal expansion, cabin pressurization and structural deformations.



CABLE TENSION REGULATOR

FQW4200 GE Metric

STUDENT NOTES

RUDDER COMPONENTS (AFT - PART 1)

Differential Mechanism
Artificial Feel Mechanism
Solenoid
AP Artificial Feel Spring Rod
Rudder Trim Actuator
Spring Rods
Centering Mechanism
Rigging Facilities
Yaw Damper Servo Actuators
Rudder Servo Controls
Transducer Units

FQW4200 GE Metric

SAFETY PRECAUTIONS

WARNING :

PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :

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- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING :

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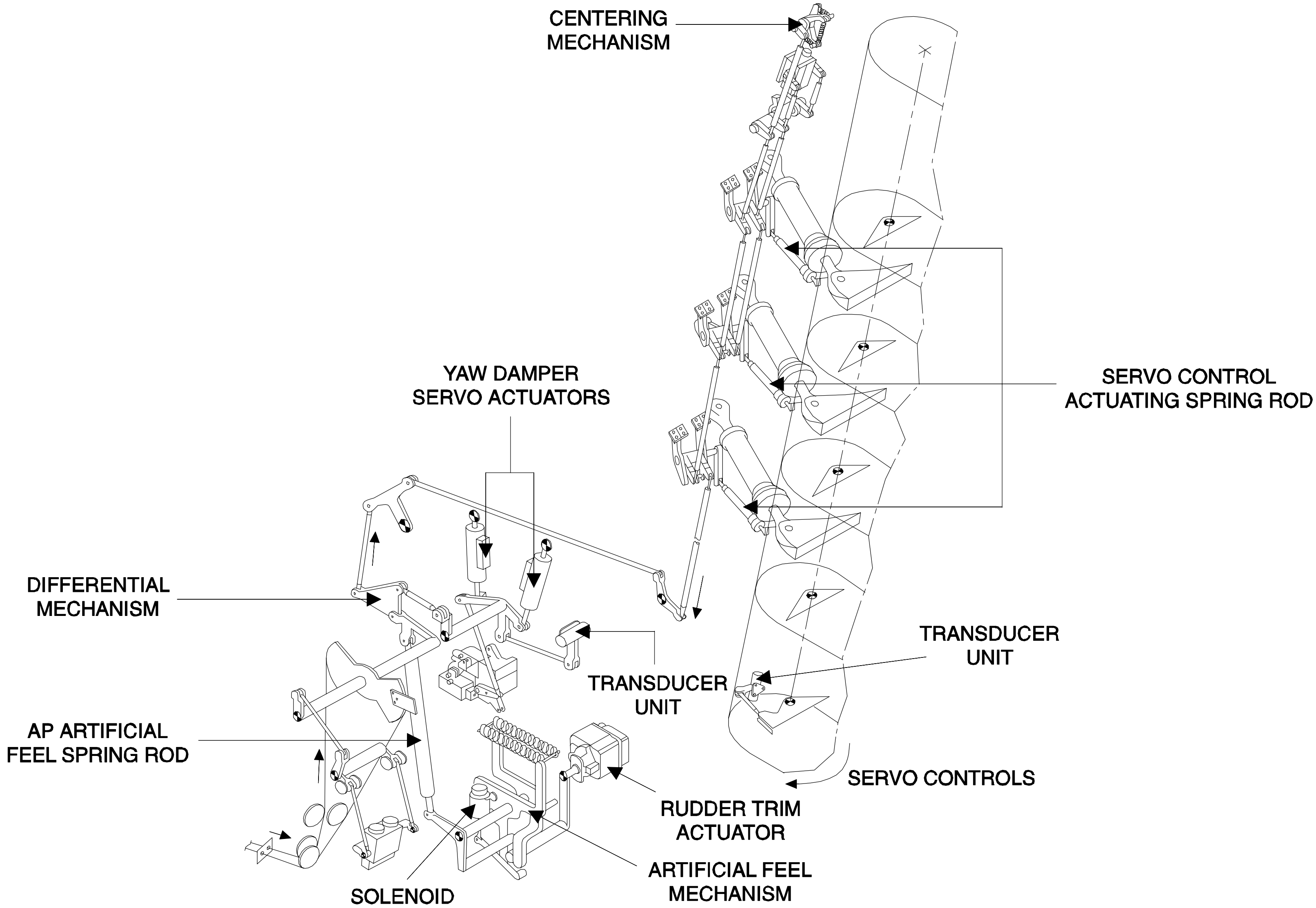
WARNING :

MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.



FQW4200 GE Metric

DIFFERENTIAL MECHANISM

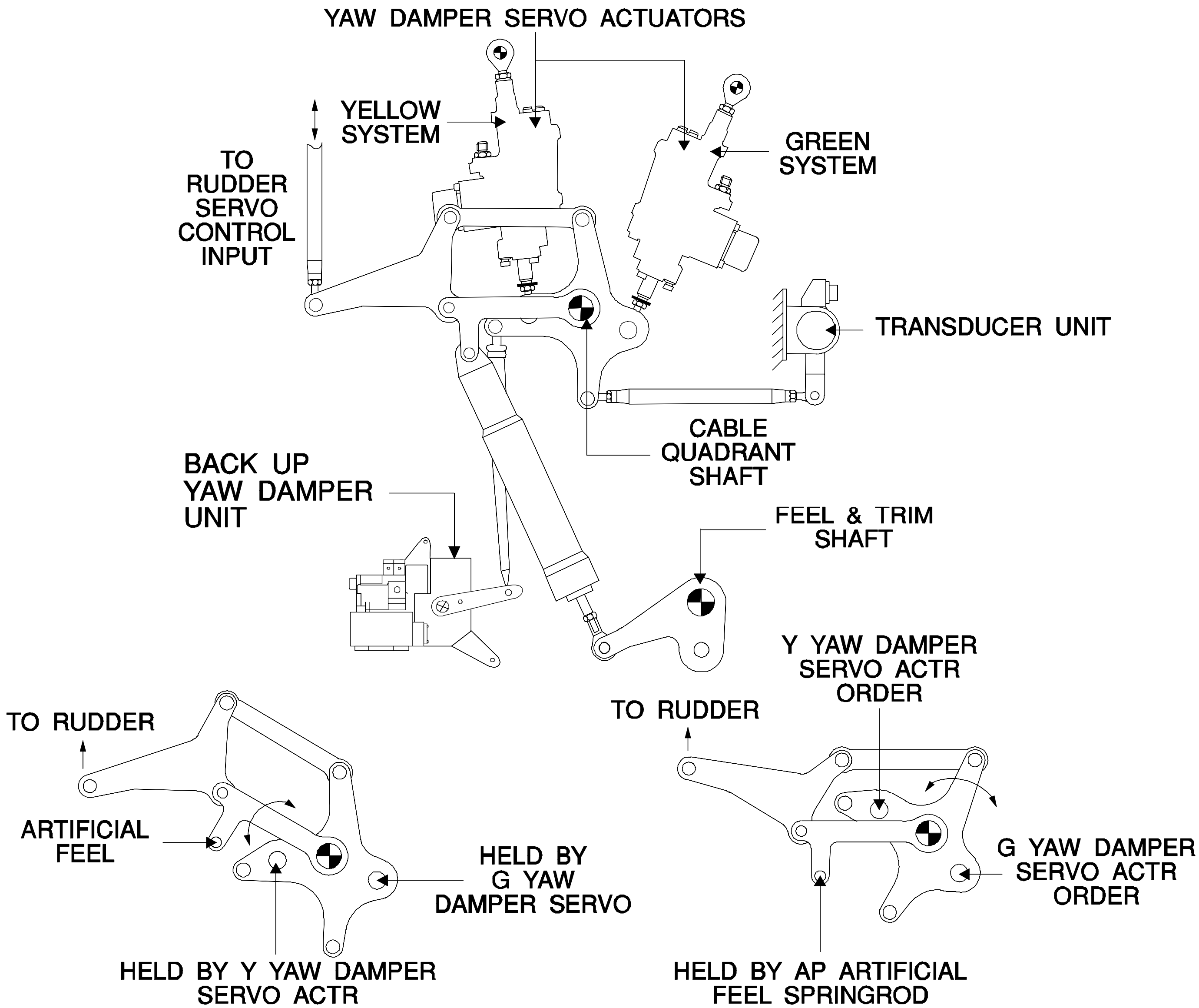
ZONE : 310

COMPONENT DESCRIPTION

This mechanism sums the orders from the pedals and from the yaw damper servo actuator.
In case of a pilot order (resulting from a motion of the quadrant), the end of the output lever has a translation motion.
Upon an order transmitted by the yaw damper servo actuators, the end of the output lever has a rotational motion.

RIGGING

The rigging point in the differential mechanism is common with the cable quadrant.



FQW4200 GE Metric

ARTIFICIAL FEEL MECHANISM

ZONE : 310

COMPONENT DESCRIPTION

The forces on the rudder pedals are produced by an artificial feel system. The rotating artificial feel mechanism consists of two levers hinged on a shaft held by the rudder control frame, between which two parallel springs are installed.

OPERATION

Depending on the direction of the movement, the finger D either drives the lever A or the lever F, the finger B holding the lever F or the lever A, thus causing elongation of the springs G.

MAINTENANCE

The finger B comprises an eccentric which can be adjusted to drive the levers A and F without backlash.

SOLENOID

FIN : 16CB

ZONE : 310

COMPONENT DESCRIPTION

On the lever A is hinged a lever C, one end of which is actuated by the rod of the solenoid attached to the lever A.
The other end includes a roller which engages the end of the lever F.

OPERATION

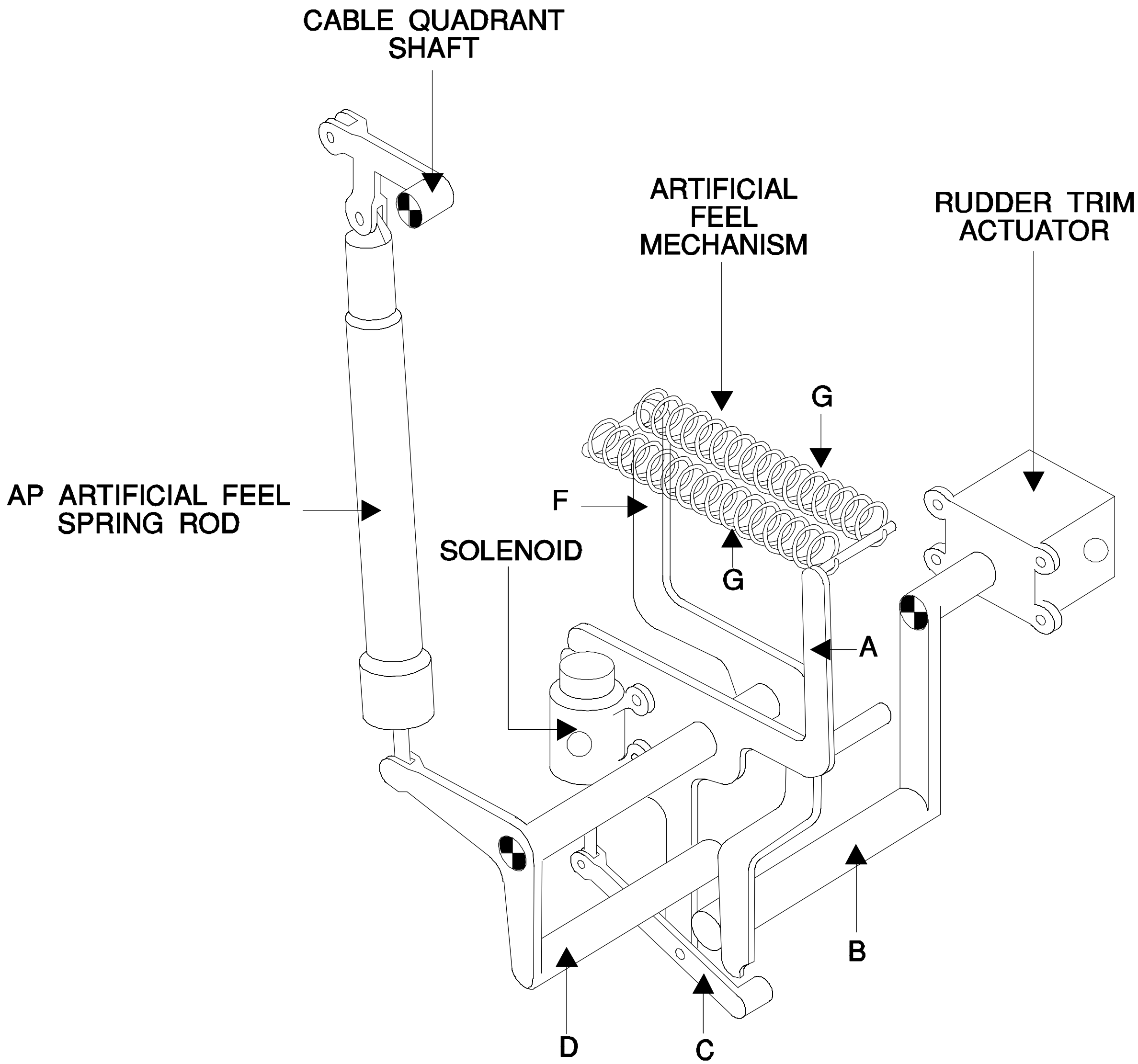
When energized in AUTOPILOT (AP) mode, the solenoid controls roller engagement, thus locking the artificial feel mechanism.
When the solenoid is de-energized, unlocking is caused by an internal spring.

AP ARTIFICIAL FEEL SPRING ROD

ZONE : 310

COMPONENT DESCRIPTION

The spring rod load threshold is higher than the maximum force generated by the artificial feel mechanism.
In AP mode, locking of the artificial feel mechanism sets the spring rod into operation.



FQW4200 GE Metric

RUDDER TRIM ACTUATOR

FIN : 21CS

ZONE : 310

COMPONENT DESCRIPTION

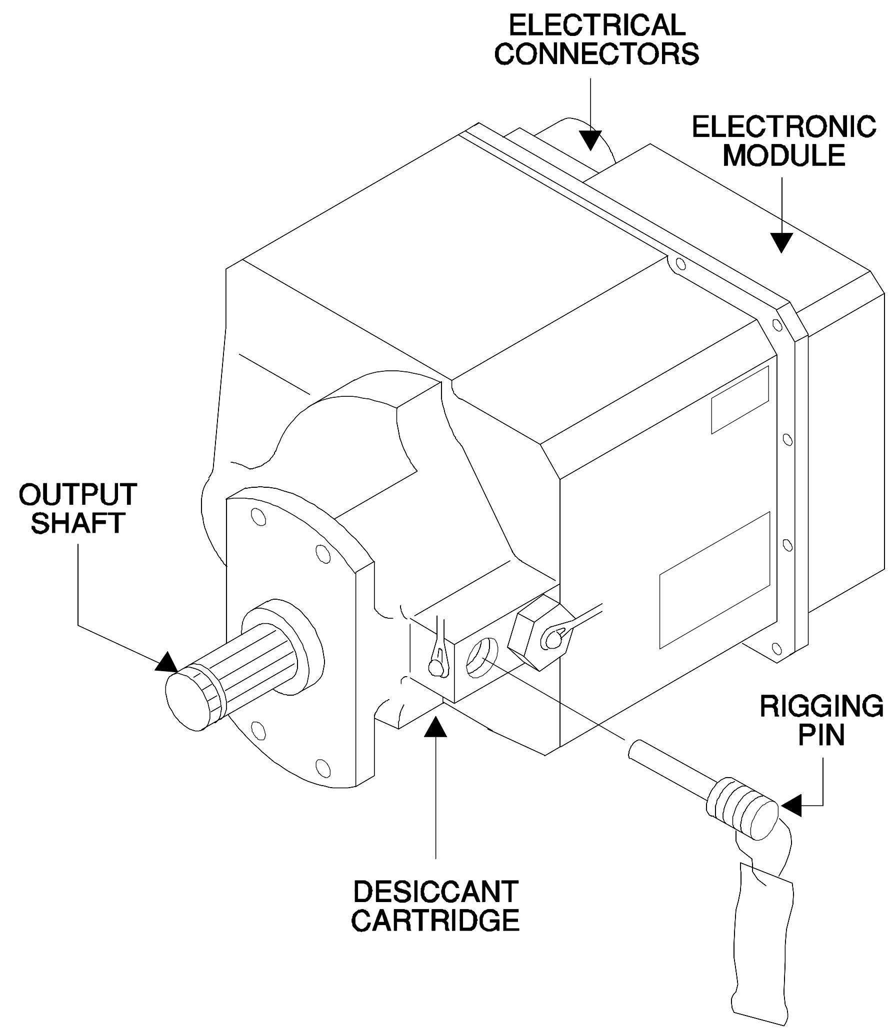
The trim actuator comprises a casing in which are installed :

- a splined output shaft
- two brushless DC motors
- four RVDTs (Rotary Variable Differential Transducers) which transmit the output shaft movement information.

MAINTENANCE

The electronic module is an LRU.

The output shaft includes a rigging point which permits adjustment to the neutral position.



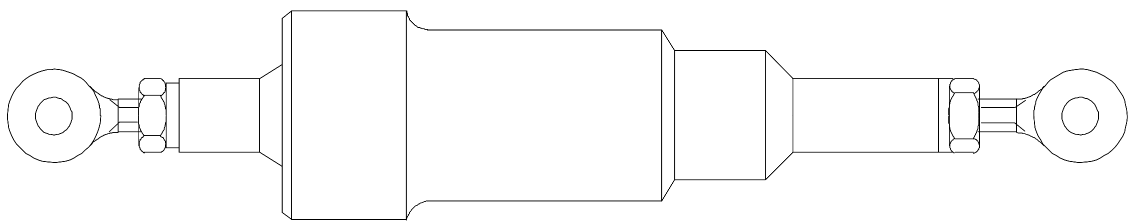
FQW4200 GE Metric

SPRING RODS

ZONE : 325

COMPONENT DESCRIPTION

Servo control actuating spring rods :
the double action load-threshold spring rods ensure the protection against jamming of the servo control input lever.



SERVO CONTROL ACTUATING SPRING ROD

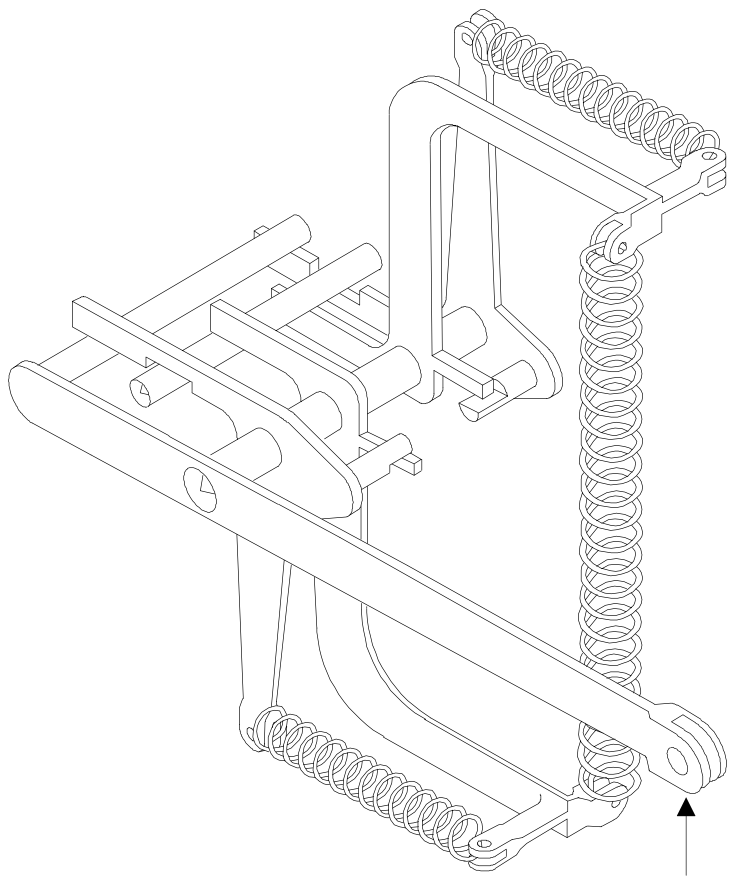
FQW4200 GE Metric

CENTERING MECHANISM

ZONE : 310

COMPONENT DESCRIPTION

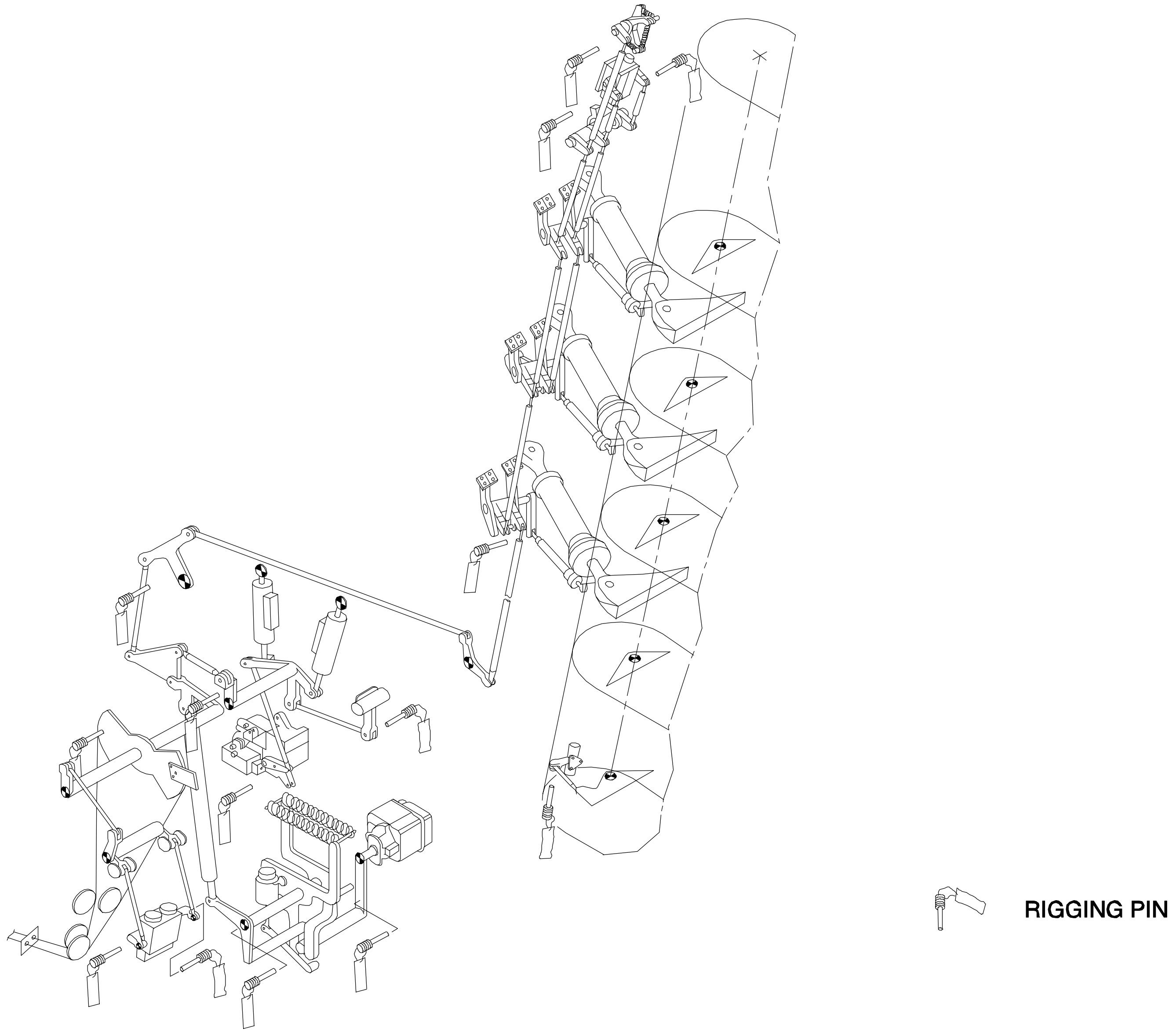
This mechanism brings back the servo control input levers to a near neutral position, if there is a disconnection of a linkage component, according to a specific force/input rotation law, defined to minimize the kinematic defects near the neutral position, in normal operation.



FQW4200 GE Metric

RIGGING FACILITIES

Here are the rigging points for the aft mechanical control of the rudder.



FQW4200 GE Metric

YAW DAMPER SERVO ACTUATORS

FIN : 19CS1/19CS2

ZONE : 310

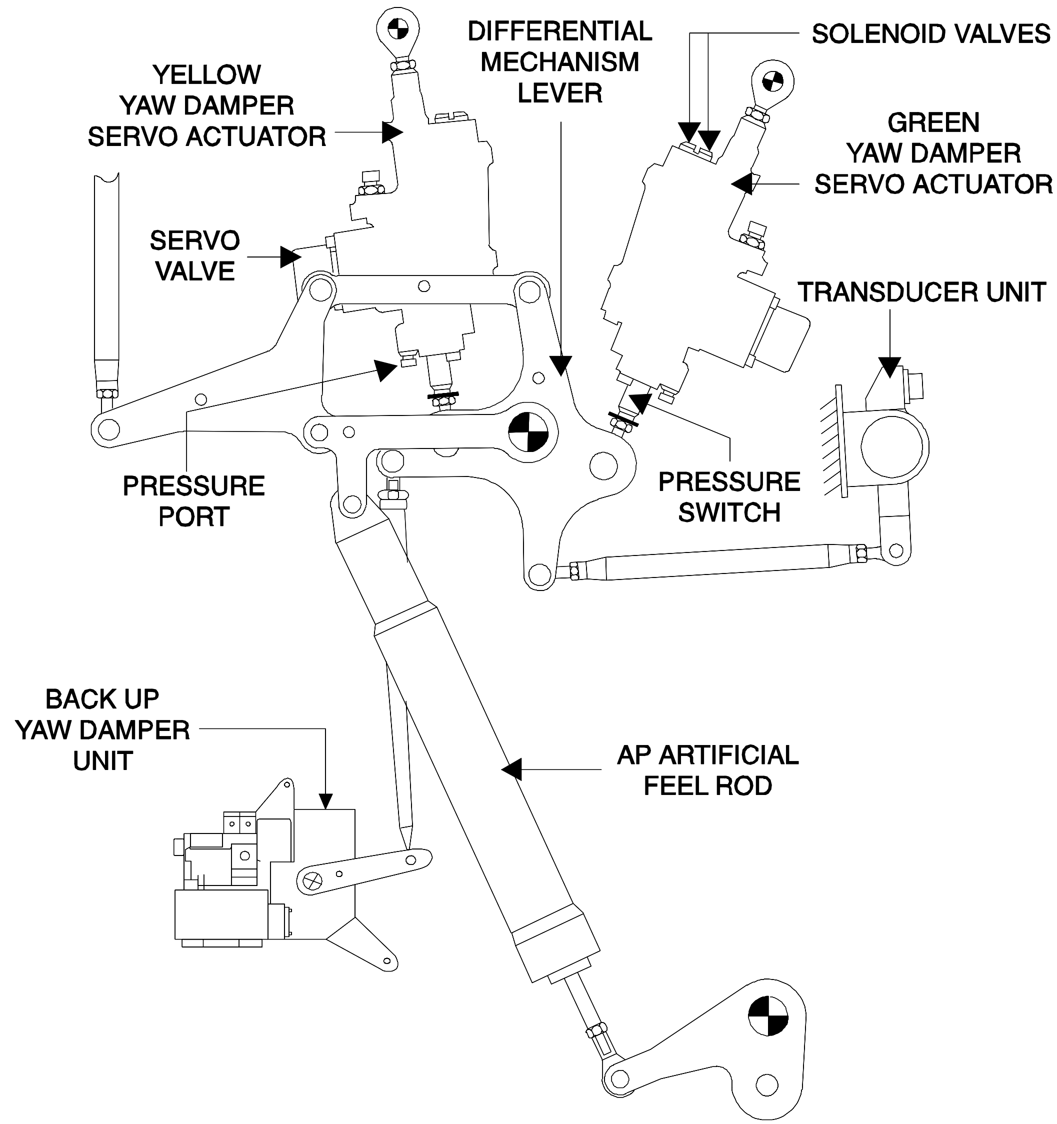
COMPONENT DESCRIPTION

The yaw damper servo actuator components listed below are self contained LRUs :

- filter
- solenoid valves
- servo valves
- pressure switch.

MAINTENANCE

No adjustment is required after replacement of the actuator.



FQW4200 GE Metric

RUDDER SERVO CONTROLS

FIN : 5002CY1
5002CY2
5002CY3

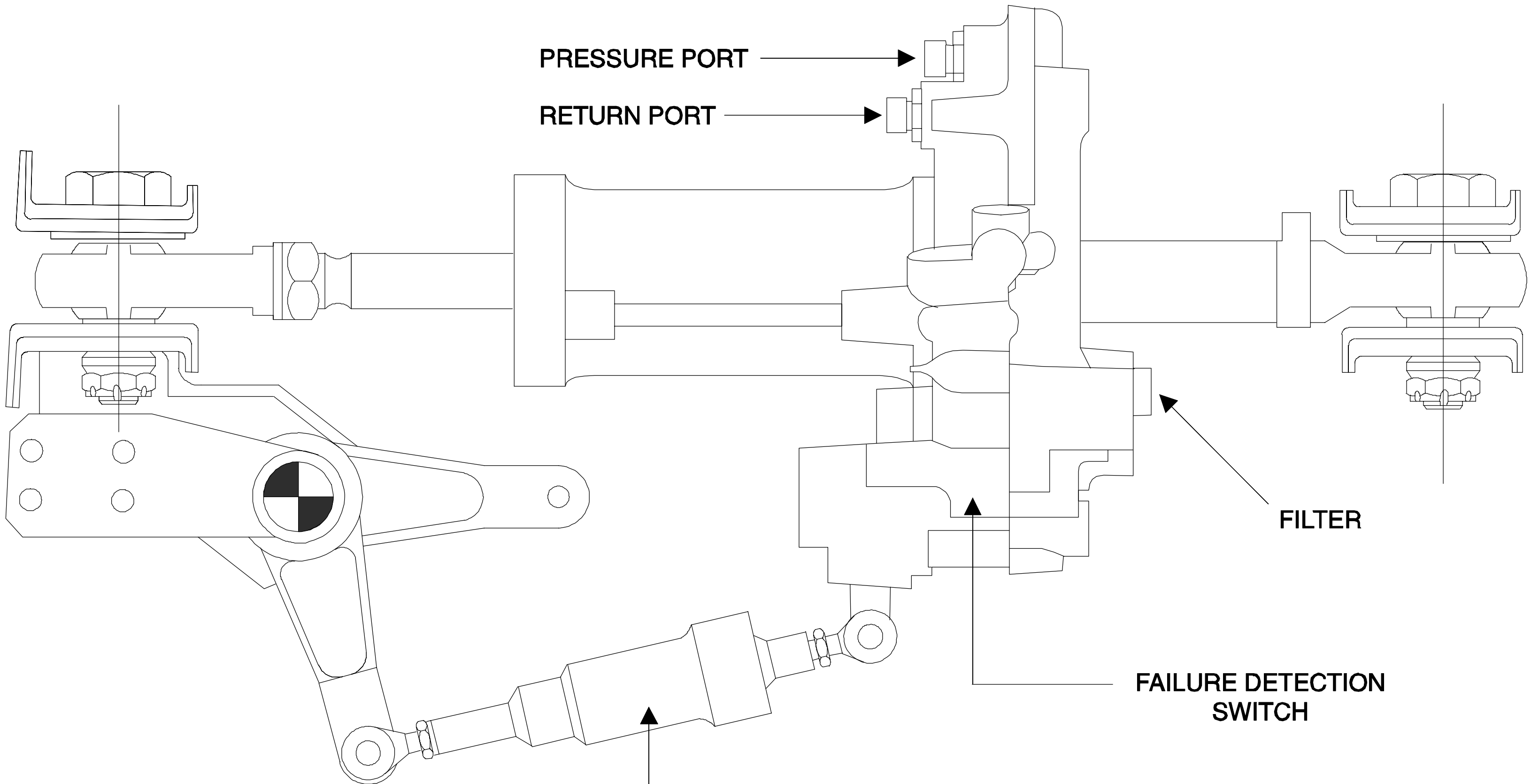
ZONE : 325

COMPONENT DESCRIPTION

The rudder is actuated by three identical moving body servo controls which operate simultaneously.
The filter and the jamming detection switch of the servo control are LRUs.

REMOVAL INSTALLATION

After replacement of the servo control, you must adjust the length of its input spring rod in order to bring the rudder in front of the reference triangle located on the tail cone.
This operation is performed with the concerned servo control pressurized and the remaining two depressurized.



FQW4200 GE Metric

TRANSDUCER UNITS

FIN : 22CS Rudder
20CS Yaw Damper

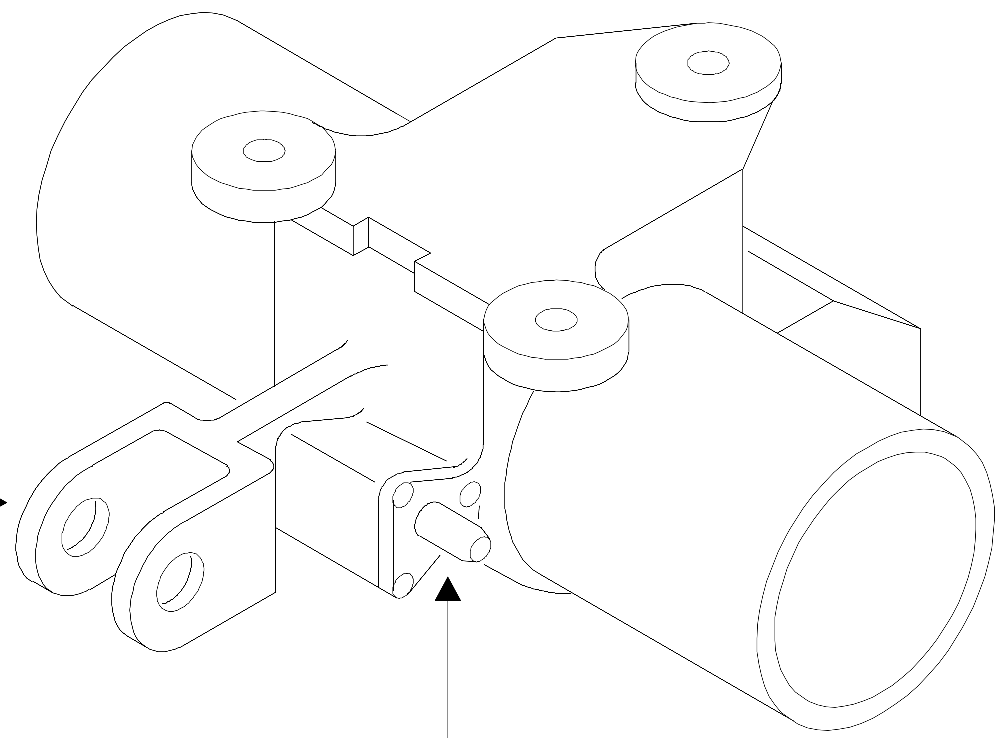
ZONE : 310

COMPONENT DESCRIPTION

The rudder transducer unit and the yaw damper transducer unit consist of a casing in which are installed two RVDTs driven by an input lever.
A built-in rigging device is provided.

OPERATION

One transducer unit transmits rudder position information to the FCPC command and monitoring units.
Another identical one transmits the position information of the lever driven by the yaw damper.



FQW4200 GE Metric

STUDENT NOTES

RUDDER COMPONENTS (AFT - PART 2)

Rudder Travel Limitation Unit
Pedal Travel Limitation Unit
Back Up Yaw Damper Unit

SAFETY PRECAUTIONS

WARNING :

PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :

- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING :

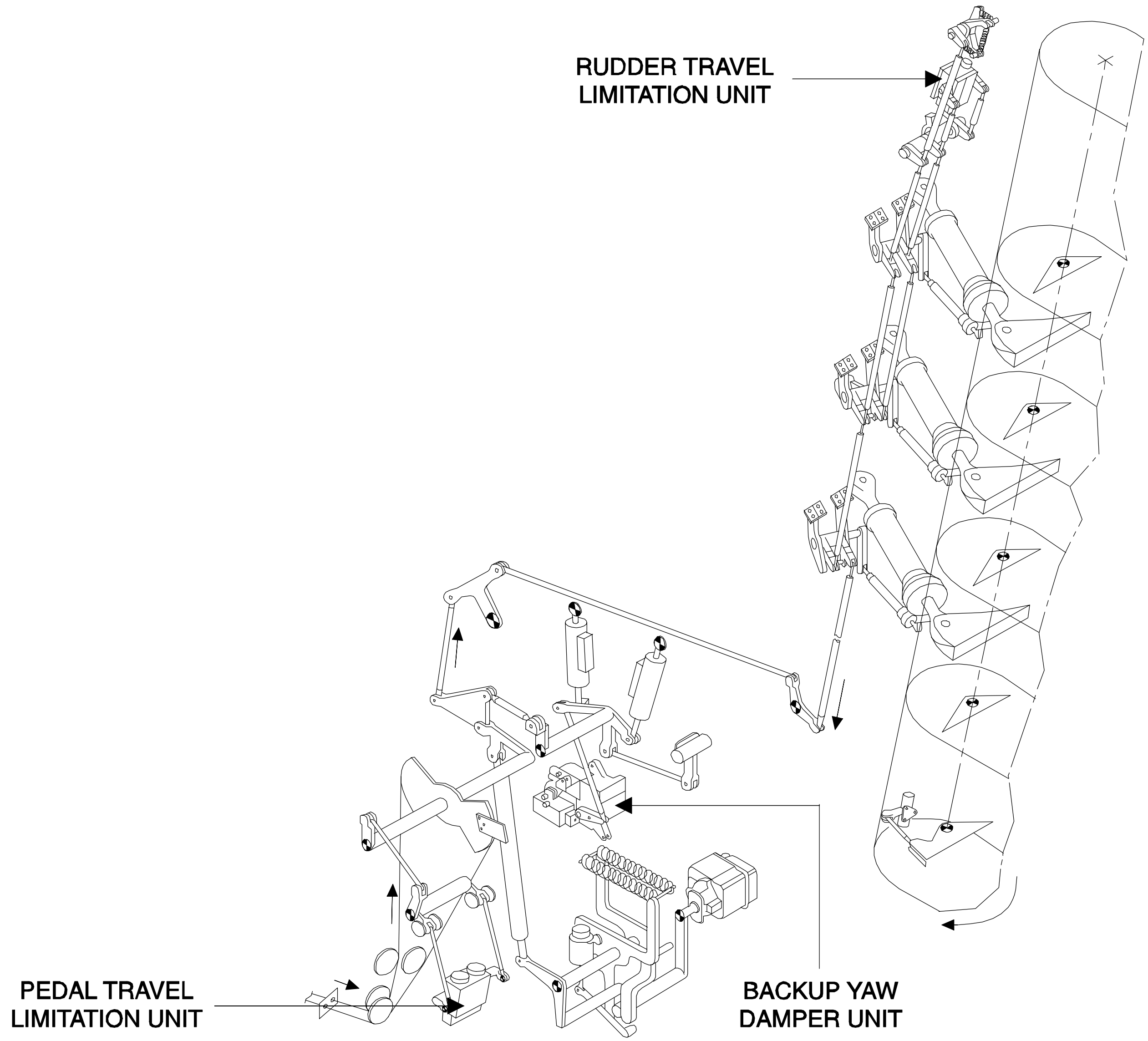
MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.



FQW4200 GE Metric

TRAVEL LIMITATION UNITS

FIN ZONE

RTLU

FIN : 24CS

ZONE : 310

PTLU

FIN : 36CS

ZONE : 310

COMPONENT DESCRIPTION

The Rudder Travel Limitation Unit (RTLU) and the Pedal Travel Limitation Unit (PTLU) are identical and interchangeable.

Both consist of a casing with several constituent parts which make a structurally redundant assembly forming two compartments in which are installed :

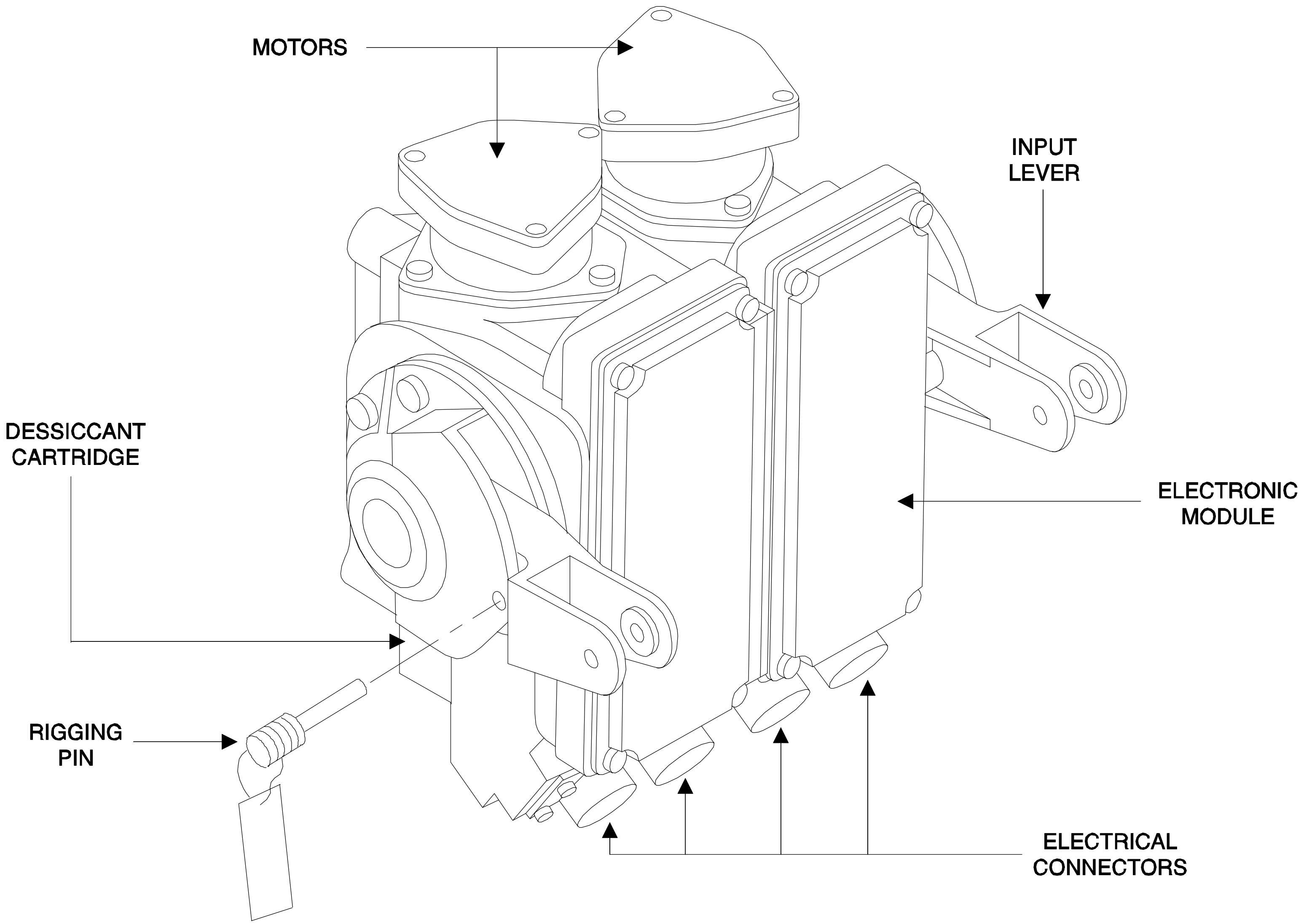
- a brushless torque motor
- two Rotary Variable Differential Transducers (RVDTs)
- a locking crossbar
- an input lever
- two connectors.

REMOVAL INSTALLATION

The electronic module is a Line Replaceable Unit (LRU).
The desiccant cartridge absorbs any residual moisture.

RIGGING

The levers and the casing have rigging holes which materialize the neutral position of the levers, for adjustment of the rods connected to them.



FQW4200 GE Metric

BACK UP YAW DAMPER UNIT

FIN ZONE

FIN : 28CS

ZONE : 312

COMPONENT DESCRIPTION

The Back Up Yaw Damper Unit (BYDU) consists of four main sub-assemblies
- one electromechanical actuator which comprises a casing with three aircraft attachment points to the rudder frame
- one electronic module attached by four points to the actuator
- two hydraulic powered identical electrical generators attached by five points on the opposite faces of the actuator

Each generator is supplied through a double winding solenoid valve which opens when both windings are not energized.
The unit is equipped with four electrical connectors.

OPERATION

STANDBY MODE (NORMAL OPERATION)

One winding of each solenoid valve at least is energized.
The output lever is driven by the active yaw damper servo actuator, the required transparency being achieved by the preloaded spring device.

ACTIVE MODE

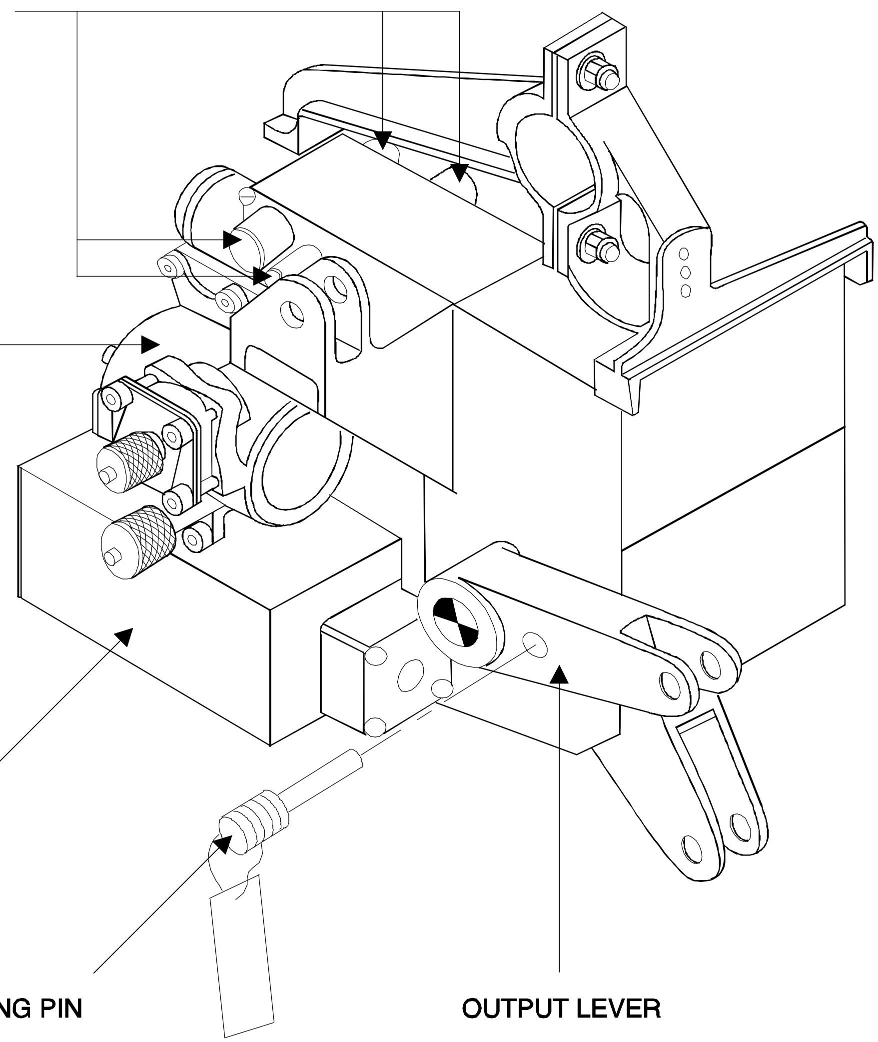
One generator solenoid valve at least is de-energized (both solenoid valve windings de-energized).
The unit generates the electrical power required for operation.
It measures the yaw rate of the aircraft and drives the rudder control through the preloaded spring device which now acts as a rigid element, according to a control law that improves the stability of the aircraft.

REMOVAL/INSTALL

Maintenance is "on condition".
The electronic module and the electrical generators are LRUs.
The lever and the casing have a rigging hole which materializes the neutral position of the lever, for adjustment of the rod connected to it.

TEST

An automatic test controlled by the FCDC permits the operation of the complete unit to be checked.
This test calls for pressurization of the Blue and Yellow hydraulic systems.



FQW4200 GE Metric

STUDENT NOTES

SPEED BRAKE AND GROUND SPOILER DESCRIPTION AND OPERATION

SPEED BRAKE FUNCTION

The Speed Brake Function is commanded in the flight phase following a pilot's action on the speed brake lever.

The surfaces ensuring this function are spoilers 1 thru 6.

PRIORITIES :

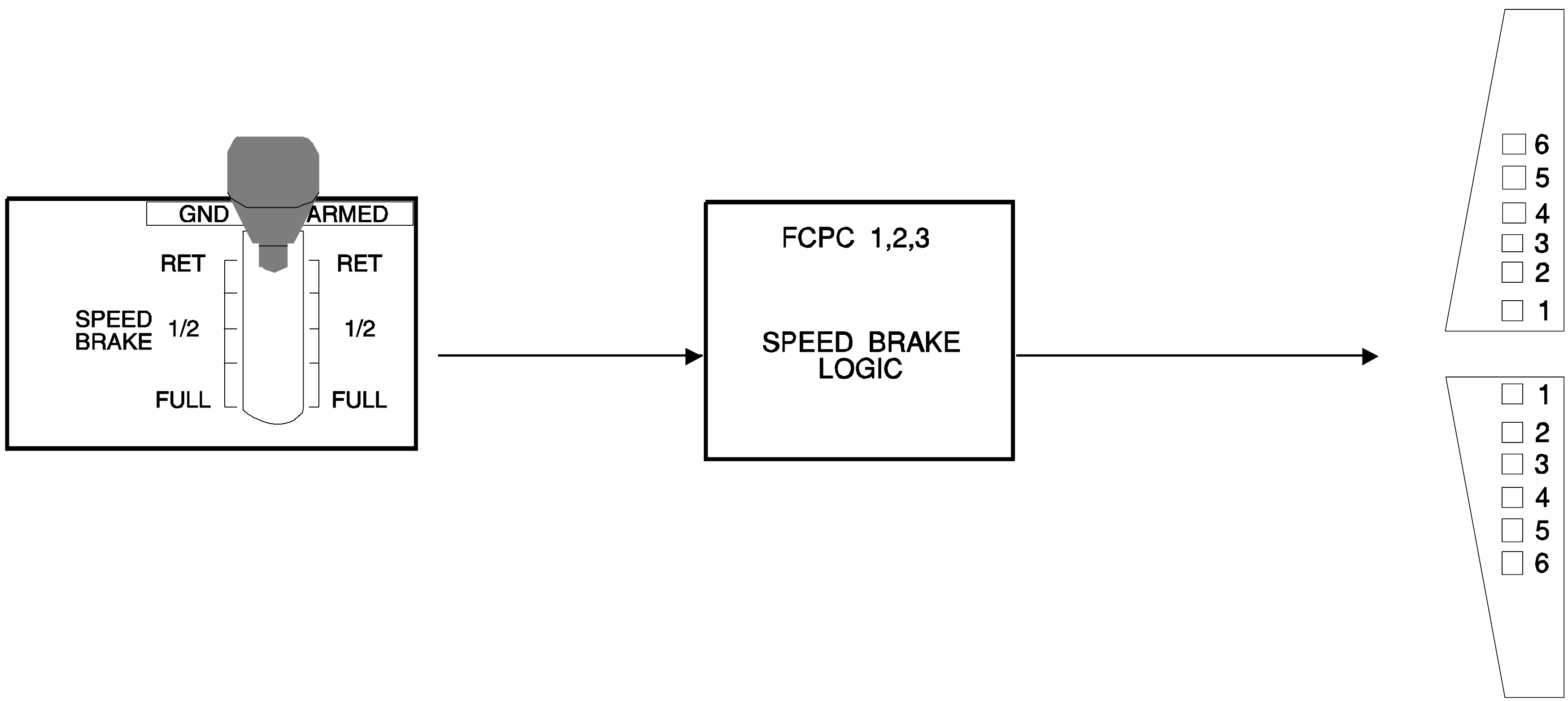
- The roll order has priority over the Speed Brake Function.
  When the sum of roll and speed brake commands, relative to one surface, is greater than the maximum possible deflection.
  The symmetrical surface is retracted until the difference between the two surfaces is equal to the roll order.

- If the angle of attack protection or the Maneuver Load Alleviation (MLA) function is activated with speed brakes extended, the speed brakes are automatically retracted.
  The retraction is announced by an Electronic Centralized Aircraft Monitoring (ECAM) message.

The switching to alternate or direct laws does not affect the Speed Brake Function.

The pitching moment associated to speed brake extension or retraction is compensated by the pitch control laws.

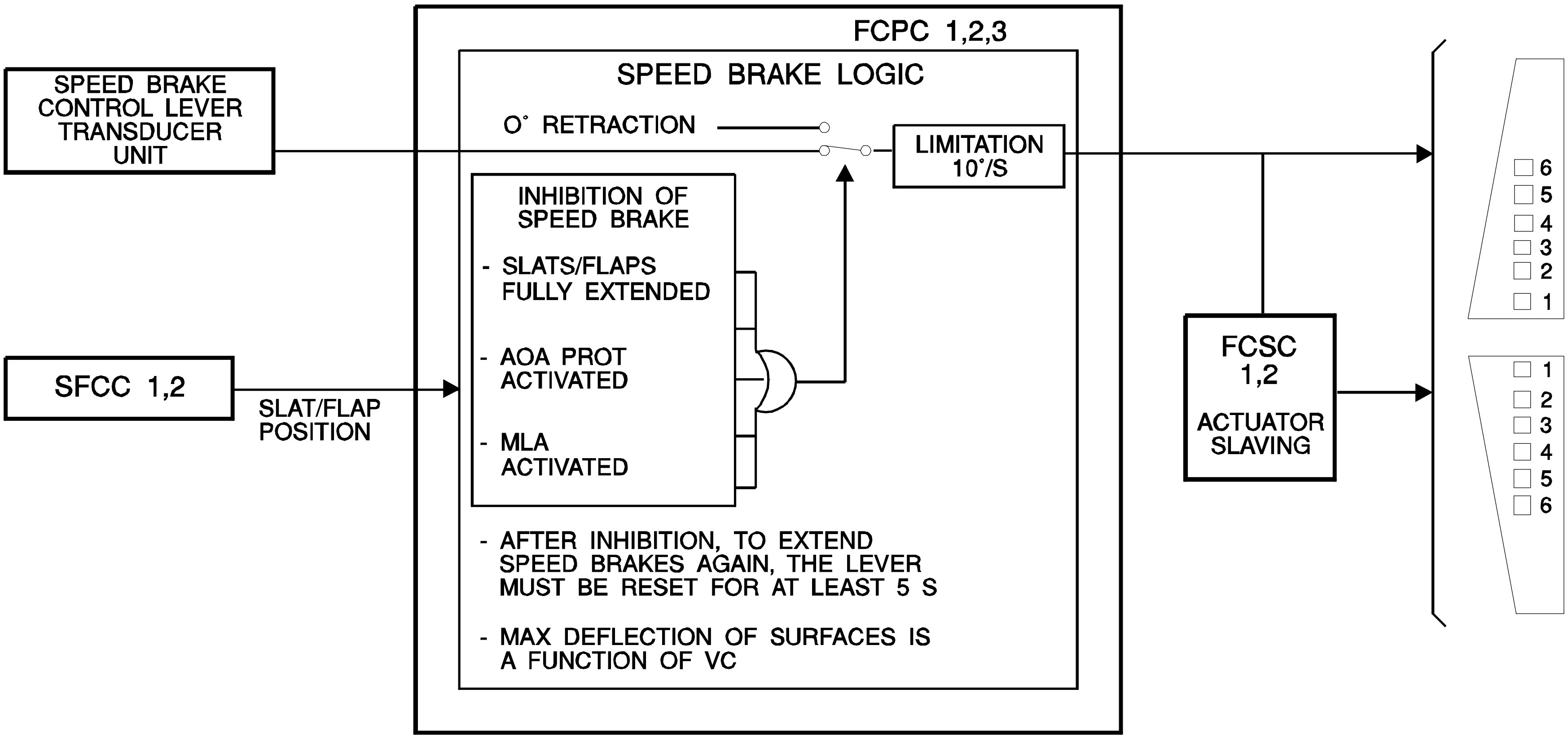
When one surface is not available on one wing, the symmetrical one is inhibited, except spoilers 4 and 6, which will stay active for roll control only.



FQW4200 GE Metric

SPEED BRAKE LOGIC

Here is the speed brake function logic in detail.



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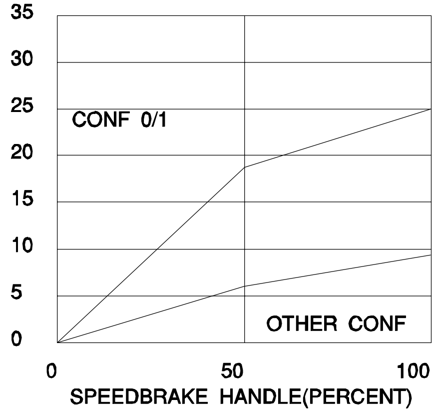
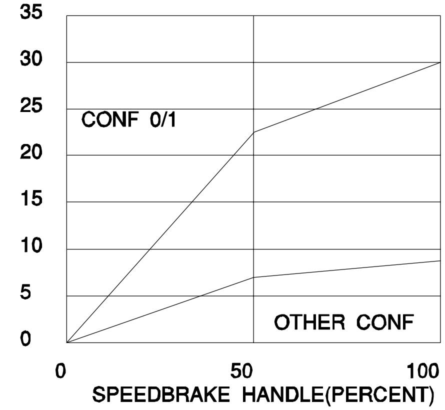
MAX SPEED BRAKE DEFLECTION

The Maximum Speed Brake surface Deflection is function of the characteristic speed Vc.

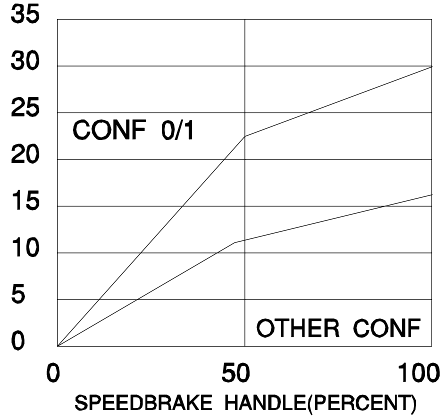
SPOILER 1 DEFLECTION



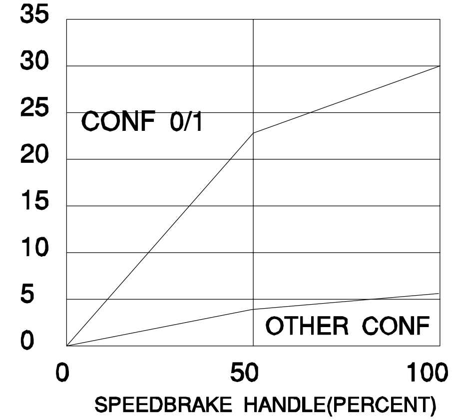
SPOILER 2/3 DEFLECTION



SPOILER 4/5 DEFLECTION



SPOILER 6 DEFLECTION

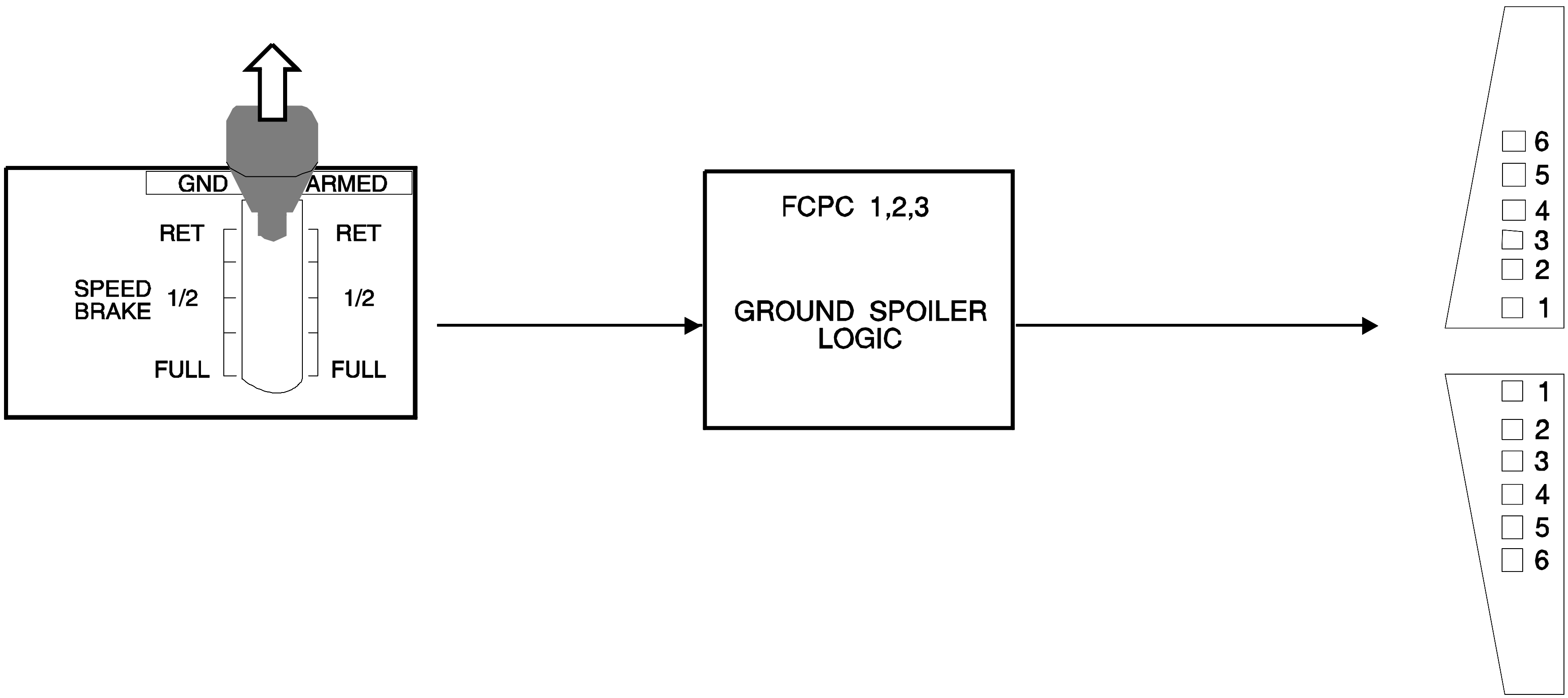


GROUND SPOILER FUNCTION

The Ground Spoiler Function is automatic.
Extension of all spoilers is achieved when the aircraft is on ground with ground spoilers armed or reverse selected.

When the logic conditions, which determine the lift dumper extension are fulfilled, a deflection order is sent to spoilers 1 to 6.

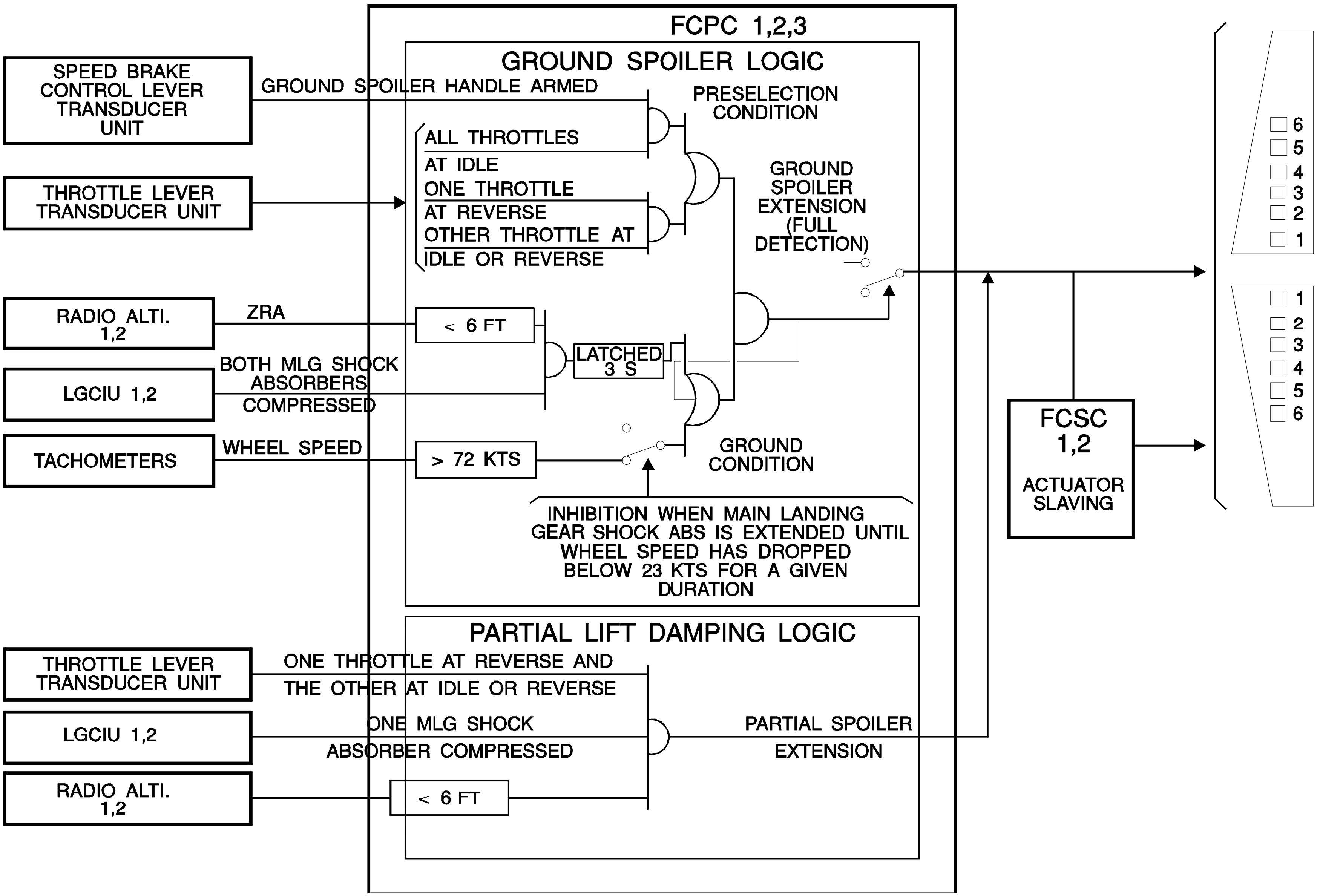
Ground spoilers are ARMED when the speed brake control lever is pulled up.



FQW4200 GE Metric

GROUND SPOILER LOGIC

Here is the ground spoiler function logic in detail.



FQW4200 GE Metric

STUDENT NOTES:

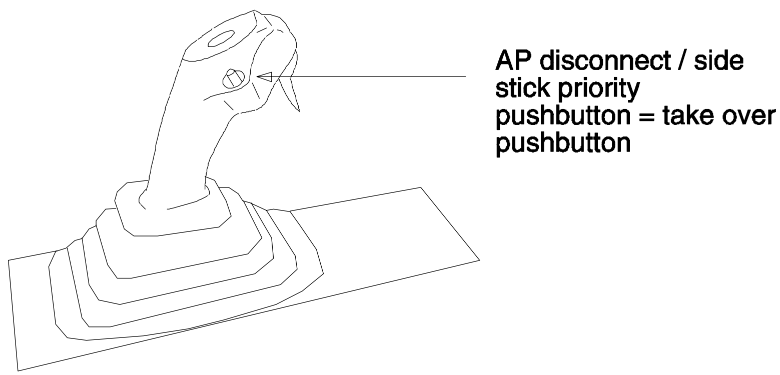
SIDE STICK OPERATION AND POSITION INDICATIONS

INTRODUCTION

The Captain and the First Officer side stick assemblies are similar. Their ergonomic characteristics are adapted for use with the left hand at the Captain's station and with the right hand at the First Officer's station.
When a side stick is not used, it is springloaded to neutral position.

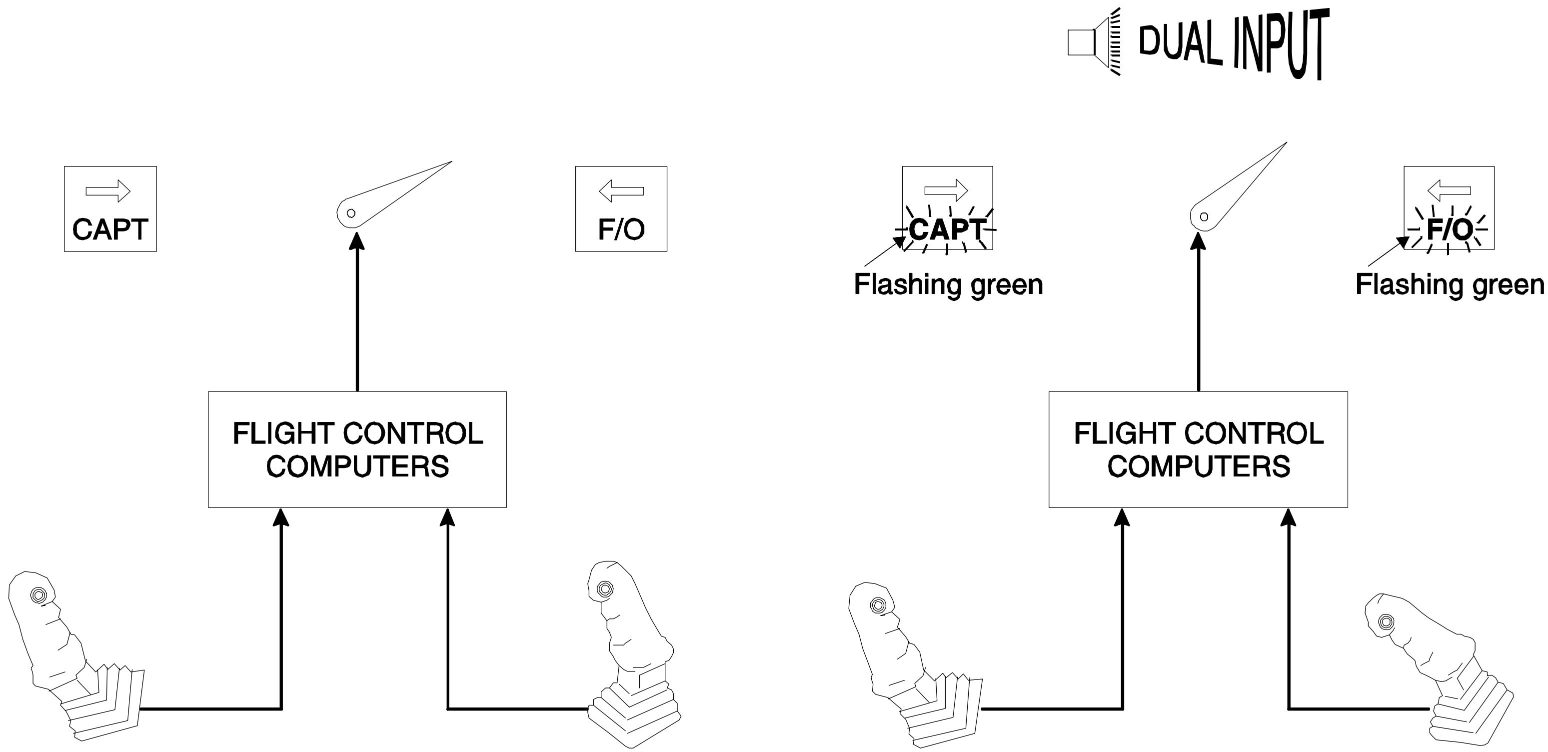
AUTOPILOT DISCONNECTION

The Autopilot mode is engaged, this mode can be disengaged when one take over pushbutton is activated.
The pilots can disconnect the AP by pressing the take over pushbutton. They can also disengage the AP by applying a force on the stick above a given threshold.


AP disconnect / side stick priority pushbutton = take over pushbutton

PRIORITY LOGIC

This logic is achieved by the Flight Control Primary Computers and the Flight Control Secondary Computers.
We are going to operate the sticks. Check the surface position after each stick movement.
The CAPT stick is moved first
When a side stick is moved, an electrical signal related to its angle deflection is sent to the system computers.
Some demand is added with the F/O stick.
When both side sticks are moved in the same direction, the signals are algebraically added. The sum is limited to single stick maximum deflection.
When both side sticks are deflected with no action on any priority switch, the two green priority lights (CAPT and F/O) are flashing and the aural indication "DUAL INPUT" is generated every 5 seconds, as long as both side sticks remain deflected



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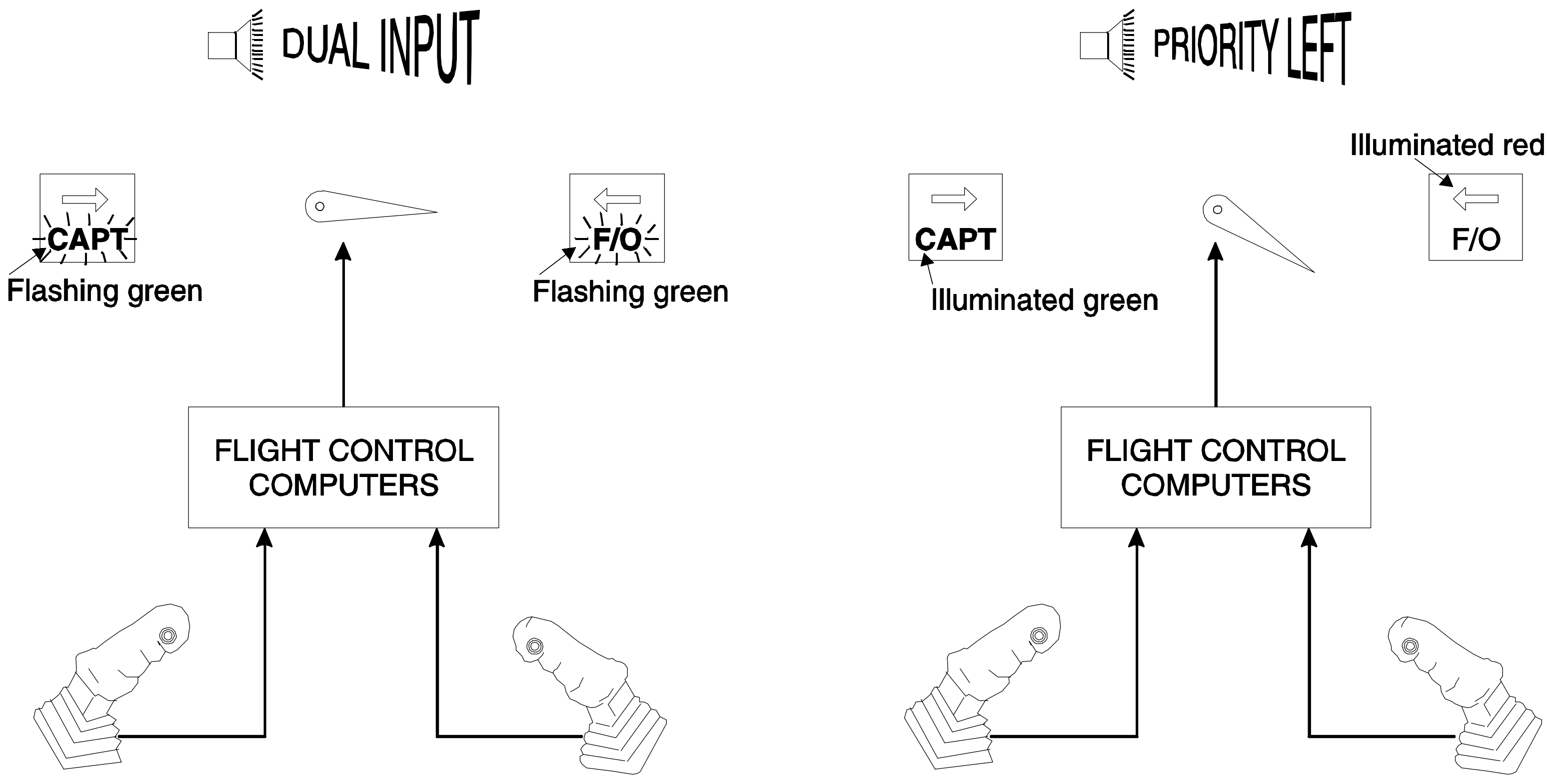
The CAPT stick is moved in the opposite direction now.
If the sticks are moved in opposite directions, the resulting demand is the difference between them.

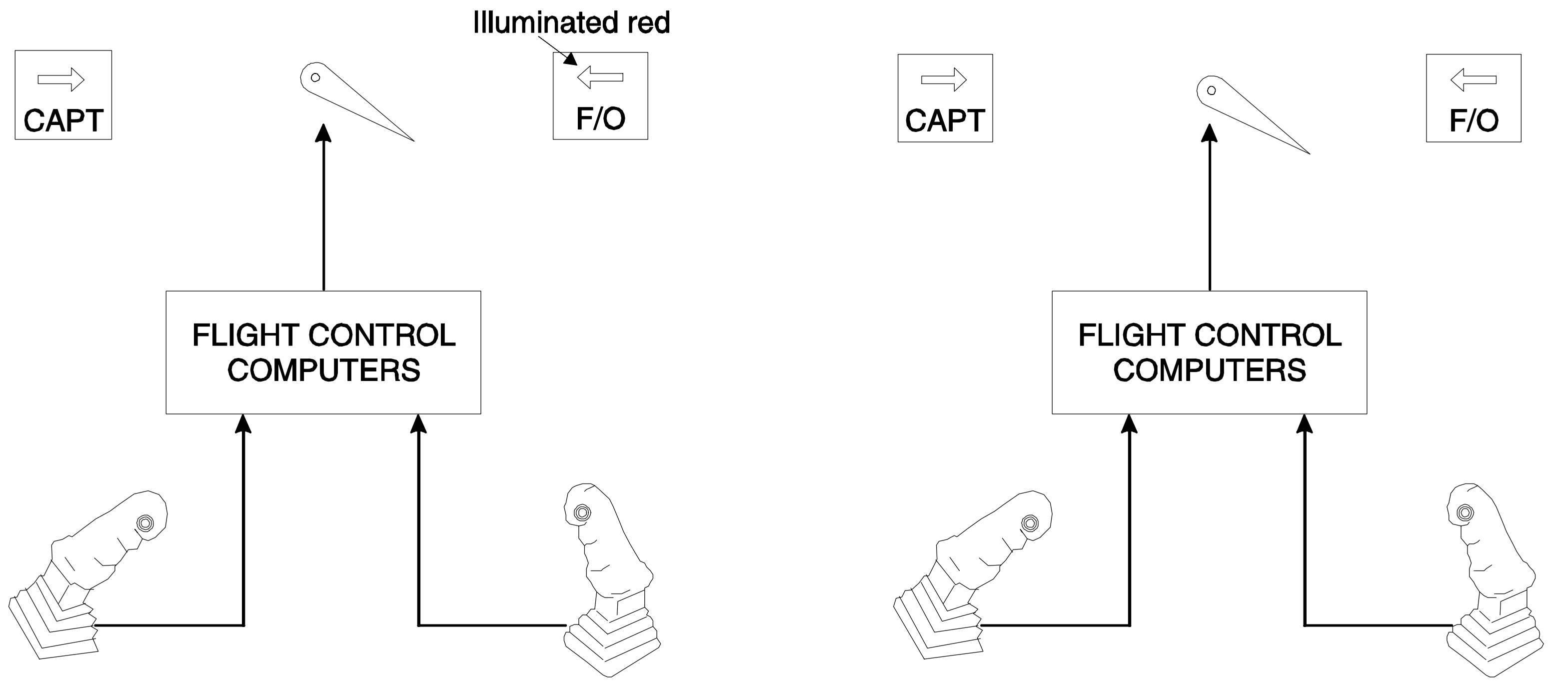
The CAPT take over pushbutton is pressed-in.
By pressing in and holding his take over pushbutton, the pilot will deactivate the other stick. A red light will come on in the front of the pilot whose stick is deactivated, accompanied by an audio call out: “PRIORITY LEFT OR RIGHT”. A green light will come on in front of the pilot who has taken control.



FQW4200 GE Metric

The F/O stick is released at neutral.
When the deactivated stick is released to neutral, the green light goes off.
A deactivated side stick can be reactivated by a momentary action on the take over pushbutton of any side stick.

The CAPT take over pushbutton is released.
When the take over pushbutton is released, the red light goes off and both side sticks become active again.
If the pilot keeps the pushbutton pressed for more than 30 s, his priority is maintained after releasing the P/BSW.



FQW4200 GE Metric

STUDENT NOTES:

ELECTRICAL FLIGHT CONTROL SYSTEM COMPONENTS

Side Stick
Side Stick Transducer Unit (TU)
Pedal Transducer Unit
Speed Brake Control Unit
Power Supply Decoupling Unit (PSDU)
Vertical Accelerometer
Rate Gyro
Hydraulic Pressure Switch
Flight Control Primary Computer (FCPC)
Flight Control Secondary Computer (FCSC)
Flight Control Data Concentrator (FCDC)
Lateral Accelerometer

SAFETY PRECAUTIONS

MAKE SURE THAT THE SIDE STICK ASSEMBLY STAYS IN VERTICAL POSITION DURING THE MAINTENANCE PROCEDURES.
THERE IS A RISK OF SKYDROL LEAKAGE.
SKYDROL CAN CAUSE INJURY AND/OR DAMAGE.

MAKE SURE THAT THE SAFETY DEVICES AND THE WARNING NOTICES ARE IN POSITION BEFORE YOU START A TASK ON OR NEAR:
- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND THE RELATED DOORS
- COMPONENTS THAT MOVE.

MOVEMENT OF COMPONENTS CAN KILL OR INJURE PERSONS.

STUDENT NOTES

SIDE STICK

Take over and priority pushbutton switch
FIN : 8CE1, 8CE2

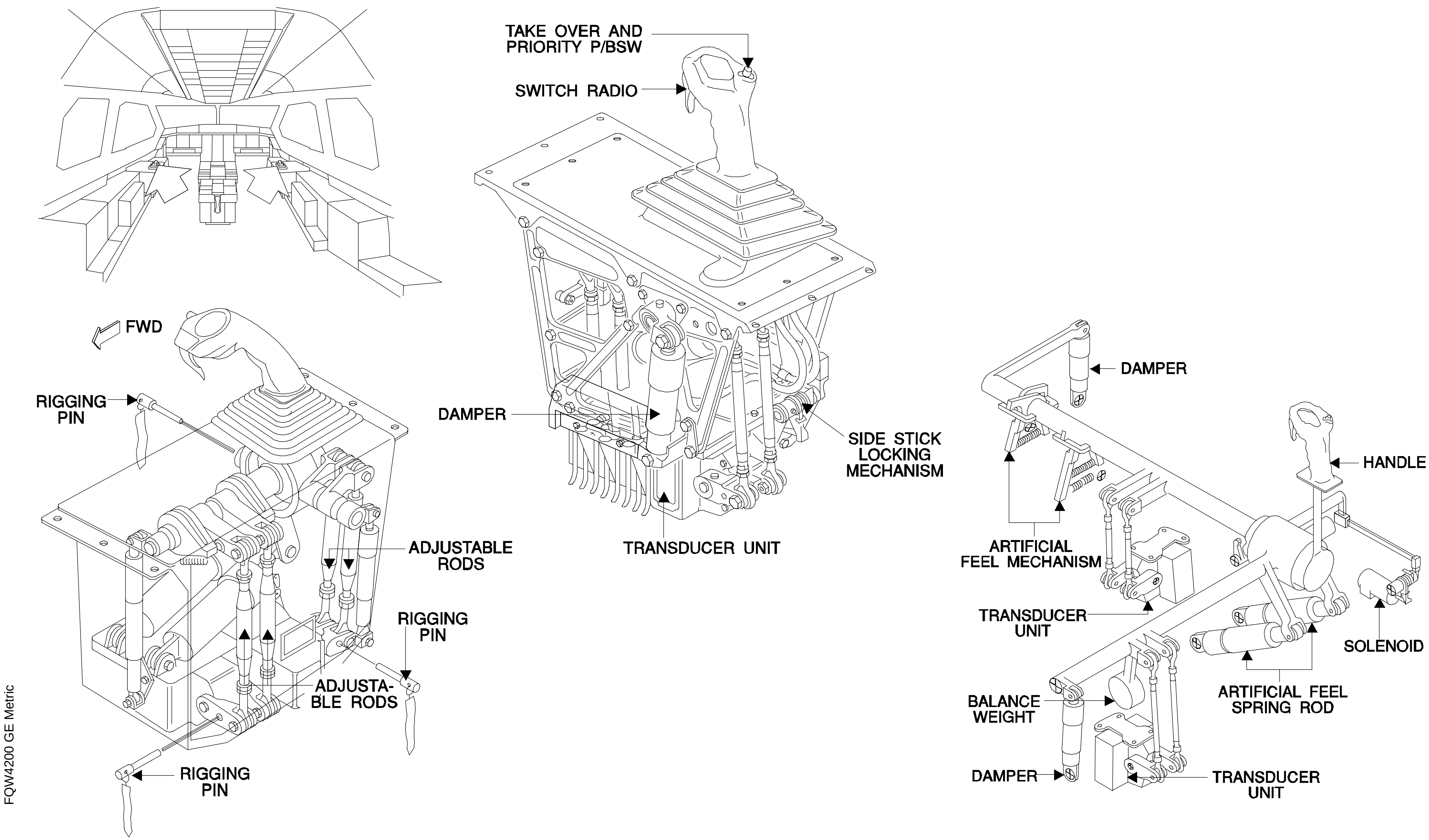
Solenoid
FIN : 12CA1, 12CA2

ZONE : 211, 212

COMPONENT DESCRIPTION

Each stick consists of a frame in which are installed :

- a hand grip,
- a pitch and a lateral control mechanism including duplicate shaft, damper and transducer units,
- a locking mechanism for AP mode.


TAKE OVER AND PRIORITY P/BSW
SWITCH RADIO
DAMPER
SIDE STICK LOCKING MECHANISM
TRANSDUCER UNIT
FWD
RIGGING PIN
ADJUSTABLE RODS
RIGGING PIN
ADJUSTA-BLE RODS
RIGGING PIN
DAMPER
HANDLE
ARTIFICIAL FEEL MECHANISM
TRANSDUCER UNIT
SOLENOID
ARTIFICIAL FEEL SPRING ROD
BALANCE WEIGHT
DAMPER
TRANSDUCER UNIT
FQW4200 GE Metric

SIDE STICK TRANSDUCER UNIT (TU)

FIN : 4CE1, 4CE2, 4CE3, 4CE4

ZONE : 211, 212

COMPONENT DESCRIPTION

A transducer unit comprises four sets of three plastic track middle point potentiometers driven by a duplicate mechanism and connected to the Flight Control Primary Computers (FCPCs) and Flight Control Secondary Computers (FCSCs) via two connectors.

PEDAL TRANSDUCER UNIT (TU)

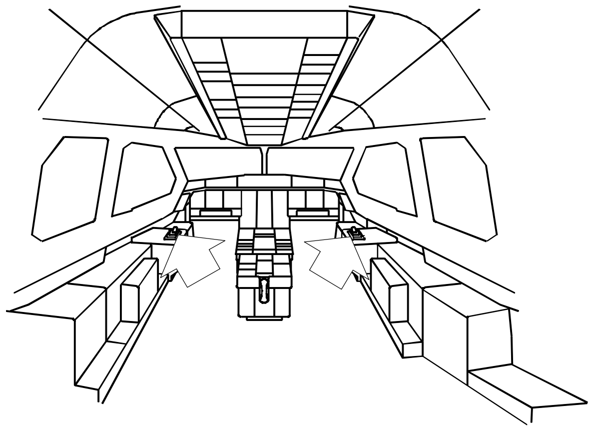
FIN : 25CE1, 25CE2

ZONE : 211, 212

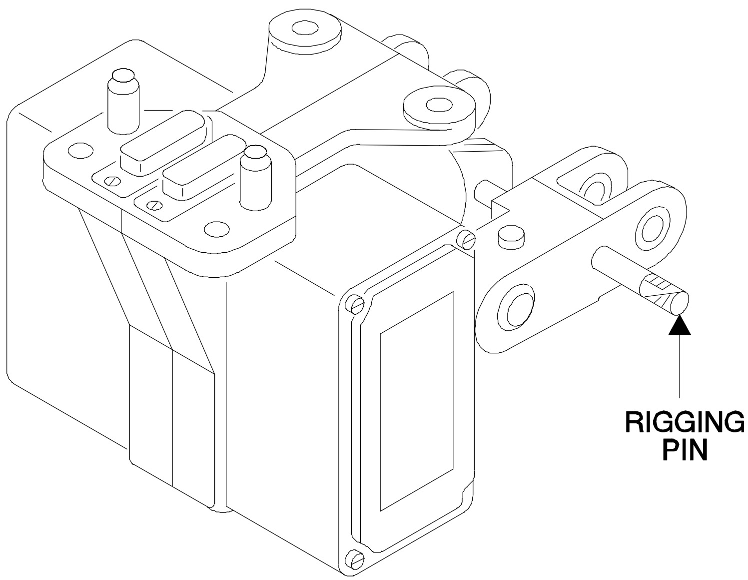
COMPONENT DESCRIPTION

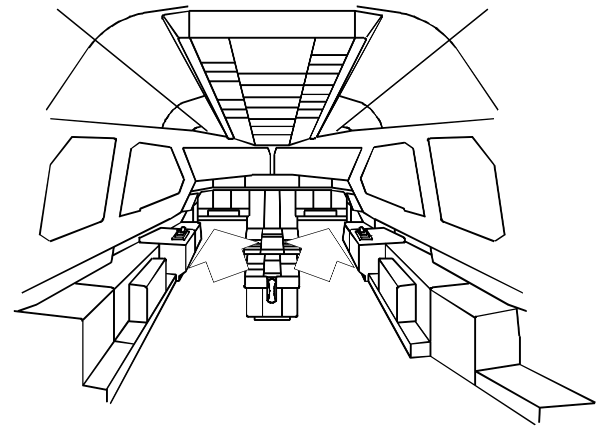
The transducer unit consists of a casing with an attachment base, in which are installed :

- an input lever whose travel is limited by stops,
- two Rotary Variable Differential Transducers (RVDTs) driven by the lever,
- two electrical connectors,
- a built-in rigging device.

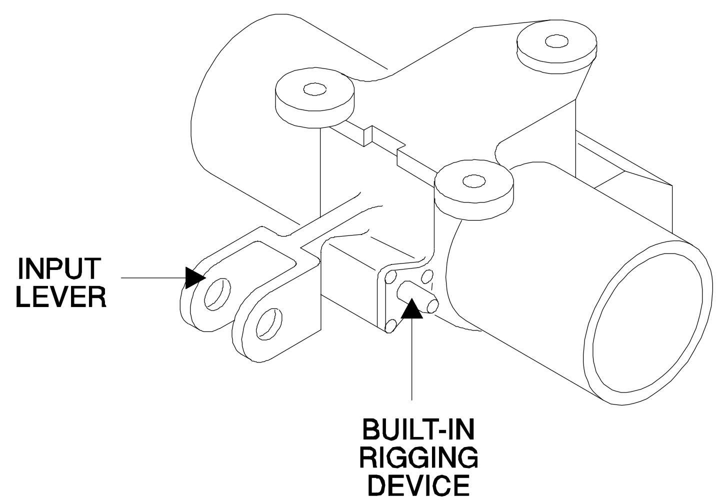


SIDE STICK TRANSDUCER UNIT





PEDAL TRANSDUCER UNIT



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SPEED BRAKE CONTROL UNIT

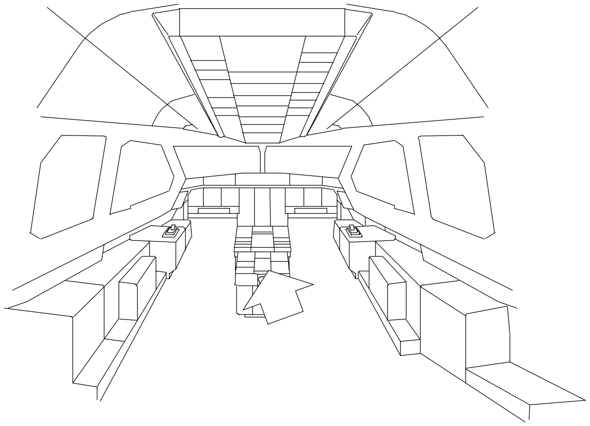
FIN : 20CE

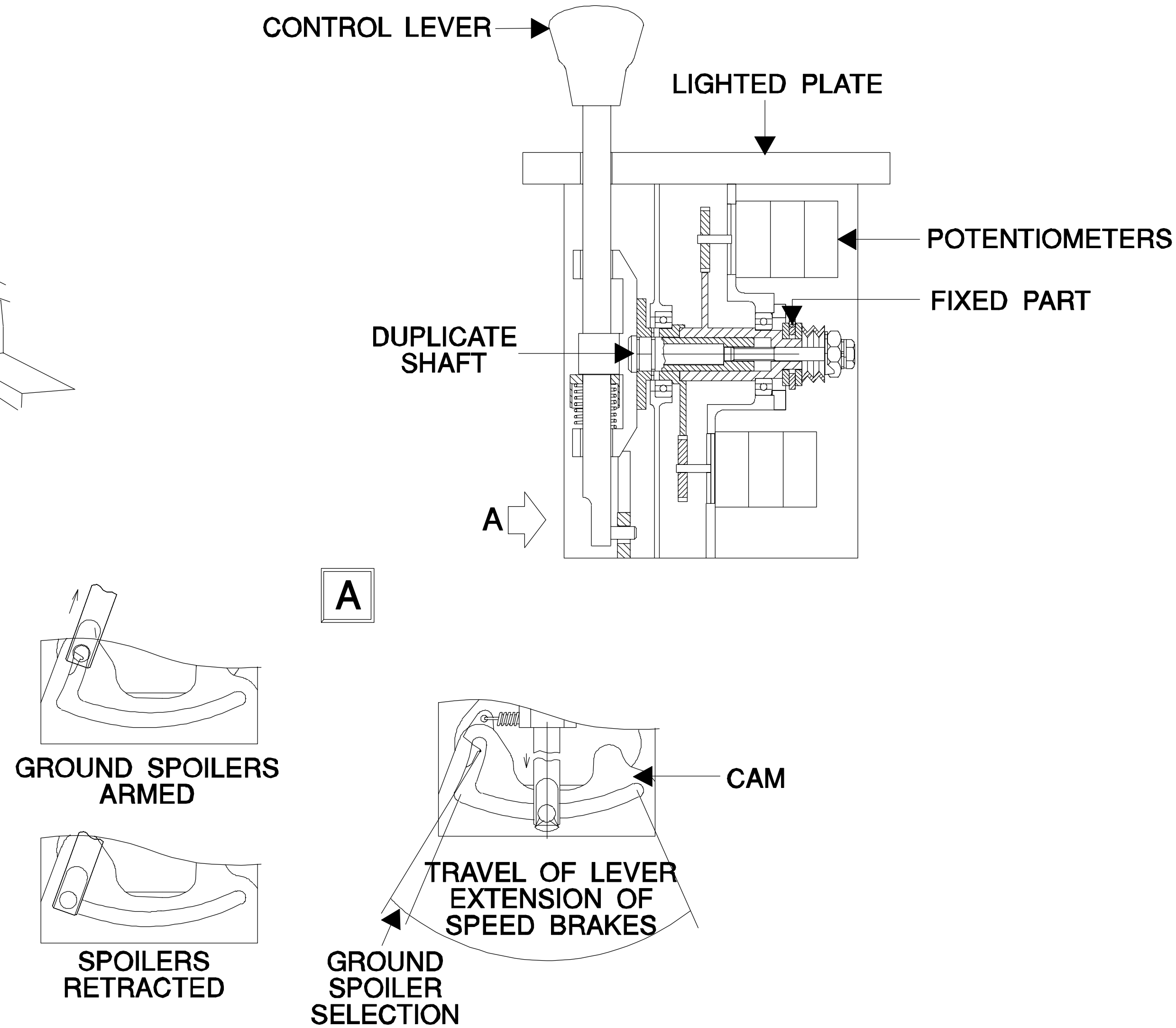
ZONE : 210

COMPONENT DESCRIPTION

The unit consists of a casing with an integrally lighted plate on the upper face in which are installed :

- a duplicate shaft with two independent toothed sectors,
- potentiometer shafts fitted with a toothed wheel driven by the duplicate shaft sectors and connected to FCPCs,
- a control lever,
- a cam,
- four electrical connectors.





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POWER SUPPLY DECOUPLING UNIT (PSDU)

FIN : 13CE, 17CE

ZONE : 121

COMPONENT DESCRIPTION

The diode unit permits decoupling of the FCPC1 and FCSC1 normal and battery power supplies.
Decoupling is achieved via two power diodes.
Three diodes are used for lightning strike protection.

VERTICAL ACCELEROMETER

FIN : 16CE1, 16CE2

ZONE : 122

COMPONENT DESCRIPTION

Each unit consists of a casing with attachment points in which are installed :

- an accelerometer in the form of a pendulum servoed in position,
- an electrical connector.

RATE GYRO

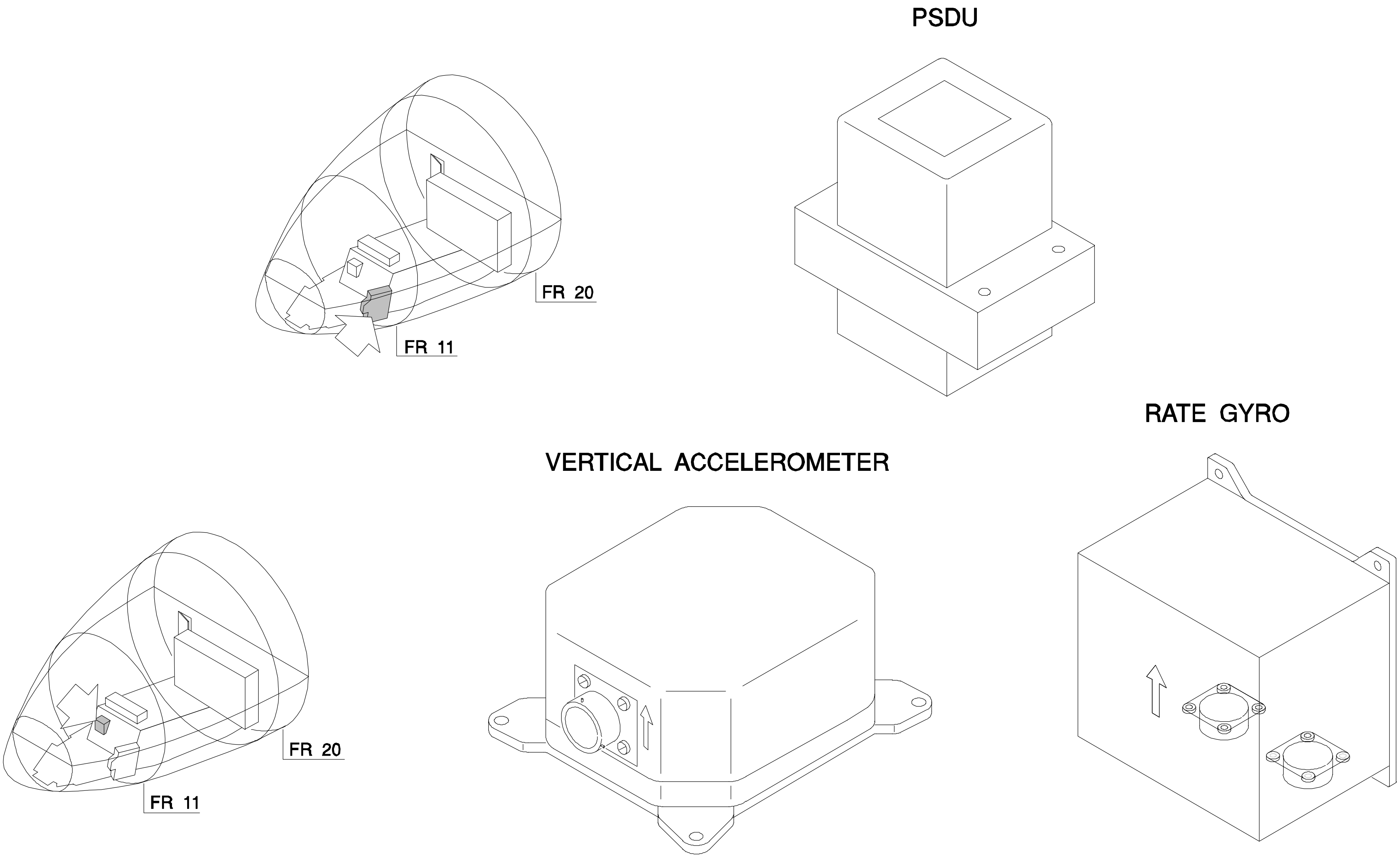
FIN : 18CE

ZONE : 122

COMPONENT DESCRIPTION

The unit comprises two identical electrically independent parts. Each part includes :

- a rate gyro which consists of a spinning wheel driven by a three phase synchronous motor, held in a gimbal ring hinged on a supporting base.
Return is ensured by a torsion bar.
- an electrical connector.



FQW4200 GE Metric

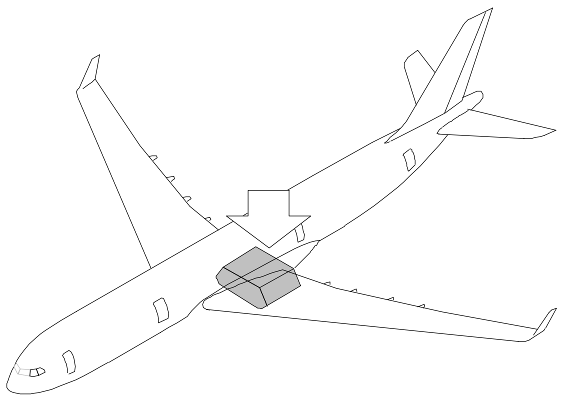
HYDRAULIC PRESSURE SWITCH

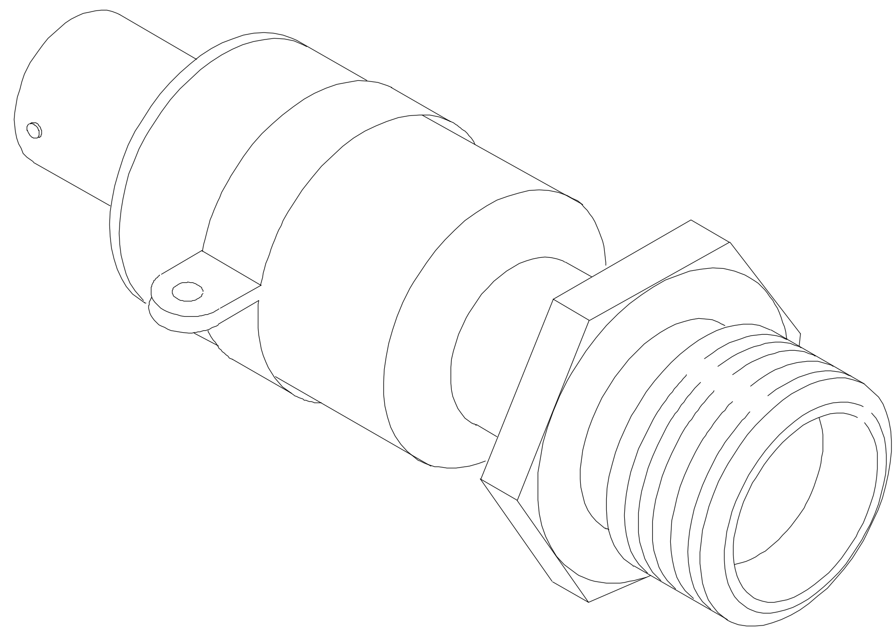
FIN : 19CE1, 19CE2, 19CE3

ZONE : 147, 195, 196

COMPONENT DESCRIPTION

The pressure switch is cylindrical with a hydraulic connection at one end and an electrical connector receptable at the other end.





FQW4200 GE Metric

FLIGHT CONTROL PRIMARY COMPUTER (FCPC)

FIN : 2CE1, 2CE2, 2CE3

ZONE : 121, 122

COMPONENT DESCRIPTION

Each FCPC consists of two channels called command (COM) and monitor (MON).
The two channels are electrically segregated and mechanically separated by two partitions which form a ventilation well.
Each channel comprises :

- a digital card and an analog card,
- a power supply card,
- the provisions required to accomodate a spare computation card,
- an OBRM and a backplane card.

FLIGHT CONTROL SECONDARY COMPUTER (FCSC)

FIN : 3CE1, 3CE2

ZONE : 121, 122

COMPONENT DESCRIPTION

Each FCSC consists of two computation channels which are physically and electrically distinct : a command channel (COM) and a monitor channel (MON).
It comprises :

- a backplane,
- two power supplies (one per channel),
- six functional cards, each channel has one main processor card (MP) with an OBRM, one servoprocessor card (SP) with an OBRM and one extension card,
- two space provisions for additional cards without OBRM.

The MP card is dedicated to calculate laws and elaborate logics.
The SP card is dedicated to the computation of servoactuator orders.

FLIGHT CONTROL DATA CONCENTRATOR (FCDC)

FIN : 1CE1, 1CE2

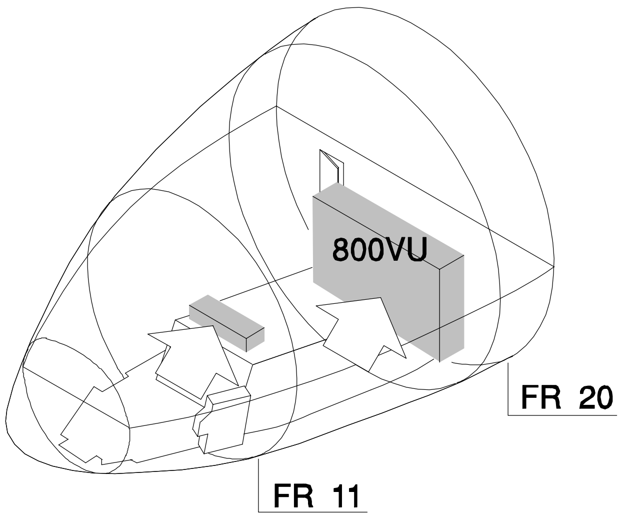
ZONE : 121, 122

COMPONENT DESCRIPTION

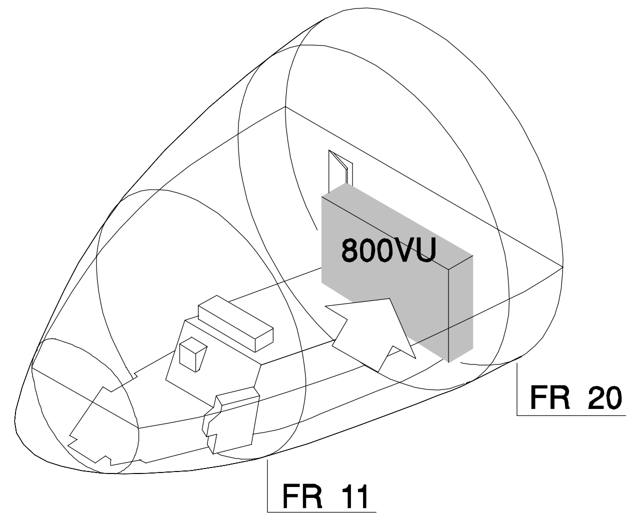
Each FCDC is single channel.
It comprises :

- one interconnection card,
- one protection card,
- one functional card.

FQW4200 GE Metric



FLIGHT CONTROL PRIMARY COMPUTER AND FLIGHT CONTROL SECONDARY COMPUTER



FLIGHT CONTROL DATA CONCENTRATOR

FQW4200 GE Metric

LATERAL ACCELEROMETER

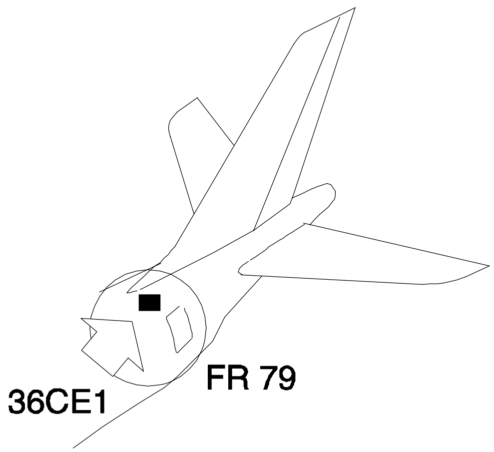
FIN : 36CE1

ZONE : 272

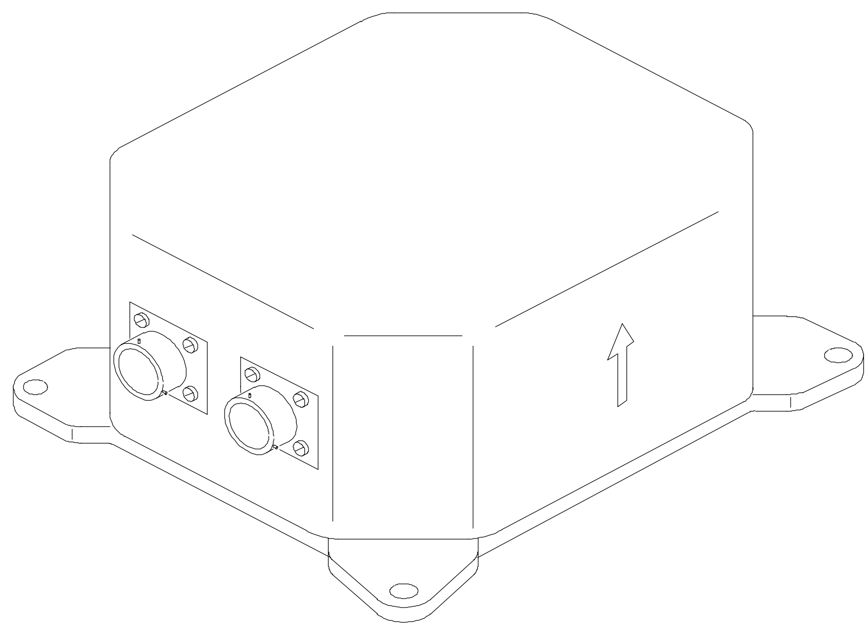
COMPONENT DESCRIPTION

This unit consists of a casing with attachment points in which are installed:

- an accelerometer in the form of a pendulum servoed in position,
- two electrical connectors.



LATERAL ACCELEROMETER



STUDENT NOTES

ELECTRIC FLIGHT CONTROL SYSTEM (EFCS) EXTERNAL INTERFACES

27 - Flight Controls
45 - On Board Maintenance
32 - Landing Gear
29 - Hydraulic Power
34 - Navigation
22 - Autoflight
76 - Engines
78 - Exhaust
28 - Fuel
31 - Indicating/Recording

27 - FLIGHT CONTROLS

The digital bus transmits the slat/flap position to all the Flight Control Primary Computers (FCPCs) and Flight Control Secondary Computers (FCSCs).
The discretes transmit the slat retracted information to the FCPCs and the slat extended information to the FCSCs.

The BUS information is used to :

- Choose the gains for control laws,
- Engage the aileron droop function,
- Calculate the limitation for Angle Of Attack (AOA) protection and caracteristic speeds.

The discretes validate the Slat Flap Control Computer (SFCC) bus.
The slat extended information is also used to allow Travel Limitation Unit (TLU) opening in case of loss of the two TLU channels in FCSCs.

45 - ON BOARD MAINTENANCE

Data is exchanged between the Flight Control Data Concentrators (FCDCs) and the Central Maintenance Computers (CMCs), which enable two communication modes, normal mode and interactive mode.

Normal mode :

* The FCDCs send the flight control system failures to the CMCs.
* The CMCs send general data (time, date, etc...), stored in the event of failure, to the flight control system through the FCDCs.

Interactive mode :

The CMCs send to the FCDCs :

* The request for consultation of the BITE inside each computer.
* The maintenance test request.

32 - LANDING GEAR

The Landing Gear Control Interface Units (LGCIUs) transmit data related to the landing gear to the FCPCs, FCSCs and FCDCs.

The FCDCs receive the nose shock absorber compressed information for elaboration of the power-up test.

The FCPCs receive the main landing gear on ground information for elaboration of ground/flight logic and ground spoiler logic.
The FCSCs receive the main landing gear extended information for law switching to the ground kinematic in case of loss of both SFCCs.

The main gear wheel tachometers transmit the wheel speed data used in ground spoiler logic to the FCPCs.

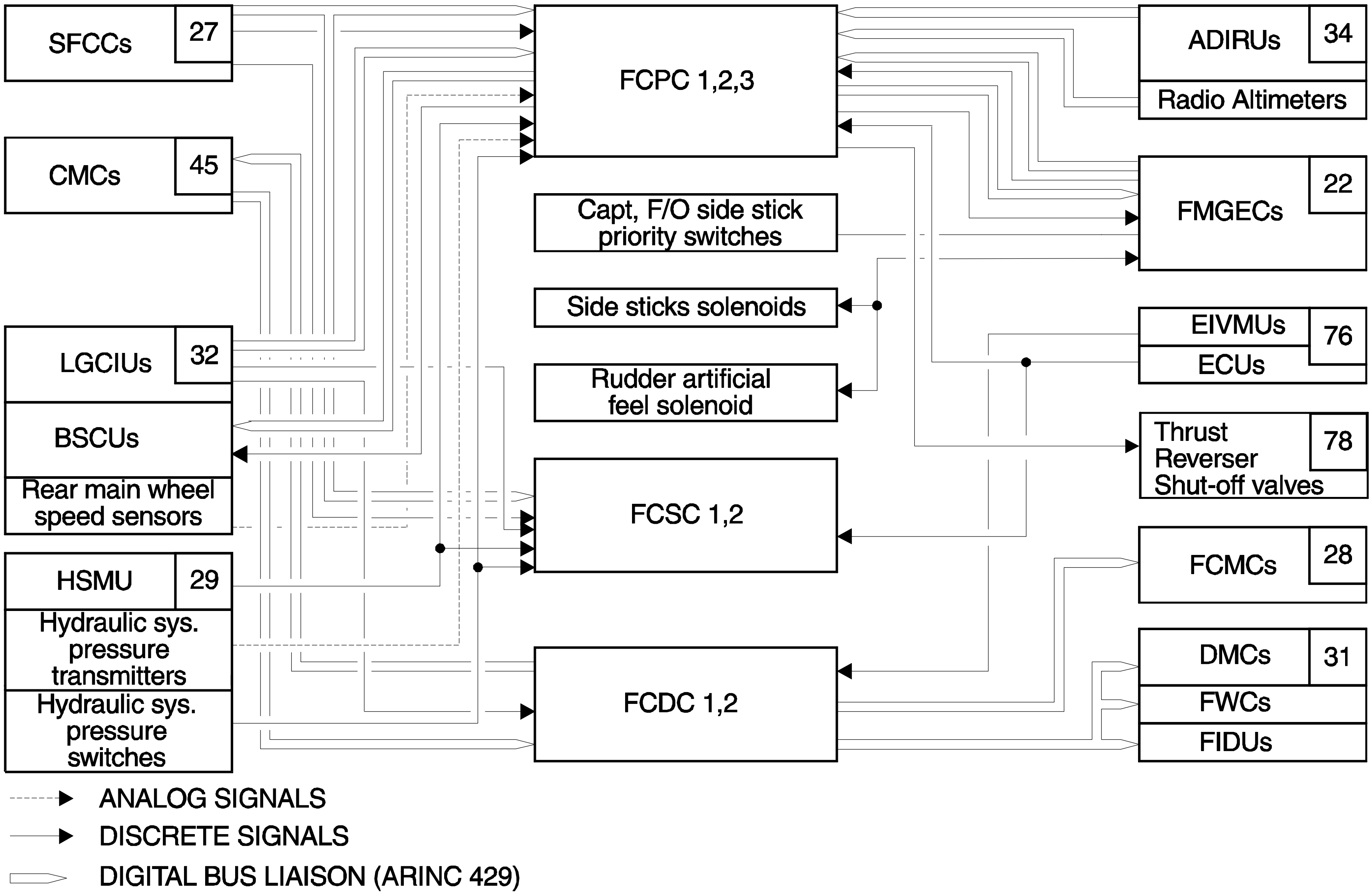
The FCPCs feed the Braking and Steering Control Units (BSCUs) with the data below :

- Ground spoiler extension order, used for autobrake engagement logic,
- Nosewheel steering orders from the rudder pedals, in manual, mode and from Flight Management and Guidance Envelope Computers (FMGECs) in autopilot mode.

29 - HYDRAULIC POWER

The Hydraulic System Monitoring Unit (HSMU) transmits the Ram Air Turbine (RAT) extension information to FCPC1 and FCSC1 for green servocontrol speed limitation.

Hydraulic pressure switch signals are acquired by FCPC2, 3 and FCSC2 for the servoing reconfigurations in case of hydraulic failure.
The pressure transmitter information enables the FCPCs to consolidate the data sent by the pressure switches.



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34 - NAVIGATION

The Air Data References (ADRs) and Inertial References (IRs) feed the FCPCs with inertial and air data for computation of manual control laws and characteristic speeds.

The inertial data transmitted :

Body pitch rate, pitch attitude rate, body normal acceleration, pitch attitude, bank angle, body roll rate, body yaw rate, body lateral acceleration, baro inertial altitude, baro inertial vertical speed.

The radio altimeters feed the FCPCs with altitude information for ground/flight logic.

The air data transmitted :

Dynamic pressure, static pressure, calibrated airspeed, true airspeed, mach, angle of attack.

22 - AUTOFLIGHT

The Flight Management Guidance and Envelope Computers (FMGECs) and FCPCs exchange discrete signals to establish the AutoPilot (AP) engagement logic.
When the AP is engaged, the FMGECs energize the side stick and rudder artificial feel solenoids.

The FCPCs send aerodynamic data and surface position.

The FMGECs send to the FCPCs :

The control orders for the various actuators in AP mode, the aircraft weight and center gravity data for laws and caracteristic speed computation, engine failure data for beta target computation, ground spoiler clearance when landing in AP mode.

76 - ENGINES

The throttle control lever position is received by the FCPCs.
It is used to elaborate the ground spoiler extension logic.

The Engine Control Units (ECUs) transmit engine failure information to FCPC1 and FCSC1 in order to limit the green servocontrol speed.

The FCDCs receive, from the EIVMUs, an information which indicates that the aircraft is on ground with engines shut down.
This information is used to elaborate the "A/C on ground" condition.

78 - EXHAUST

The FCPCs control the Thrust Reverser Shut-Off Valves (TRSOV). These valves isolate the thrust reversers from the aircraft hydraulic system.

28 - FUEL

The FCDCs send the Trimmable Horizontal Stabilizer (THS) position to the Fuel Control and Monitoring Computers (FCMCs) in view of a correction of computation of the fuel quantity in the THS.

31 - INDICATING/RECORDING

Data concerning the flight control system status is sent by the FCDCs to the Display Management Computers (DMCs) for display on the Primary Flight Display (PFD) and on the ECAM SD.

The flight control system failures are sent to the Flight Warning Computers (FWCs) by the FCDCs.
The FWCs elaborate the failure messages for display on the Engine/Warning Display (EWD).
The Flight Data Interface Unit (FDIU) receives from the FCDCs, the control orders, the surface positions, the indication of certain flight control system failures, for transmission to the Fight Data Recorder (FDR).

ELECTRICAL FLIGHT CONTROL SYSTEM INTERNAL INTERFACES

Transducer Units
Control Unit
Pushbutton Switches
Pin Programming And Cross Link
Servocontrol And Actuators
Travel Limitation Units (TLUs) and Rudder Trim
Actuator (RTA)
Rate Gyrometers and Accelerometers
Hydraulic Pressure Switches
Flight Control Data Concentrator (FCDC)

TRANSDUCER UNITS

Transducer Units transmit the position information of the left and right rudder pedals to the Flight Control Primary Computers (FCPCs) and of the side stick on each axis, to the FCPCs and Flight Control Secondary Computers (FCSCs) for law elaboration.

Others transmit the position of the lever driven by the yaw damper servo actuator and of the left and right elevator to the FCPCs and FCSCs for monitoring of the servoing.

The rudder position is transmitted to the FCPCs for computation of the estimated sideslip and indication of the rudder position on the Electronic Centralized Aircraft Monitoring (ECAM) page.

CONTROL UNIT

The speedbrake Control Unit sends, to the FCPCs, the deflection orders of the spoilers depending on the control lever position.
The rudder trim Control Unit transmits, to the FCPCs, the trim actuator orders.

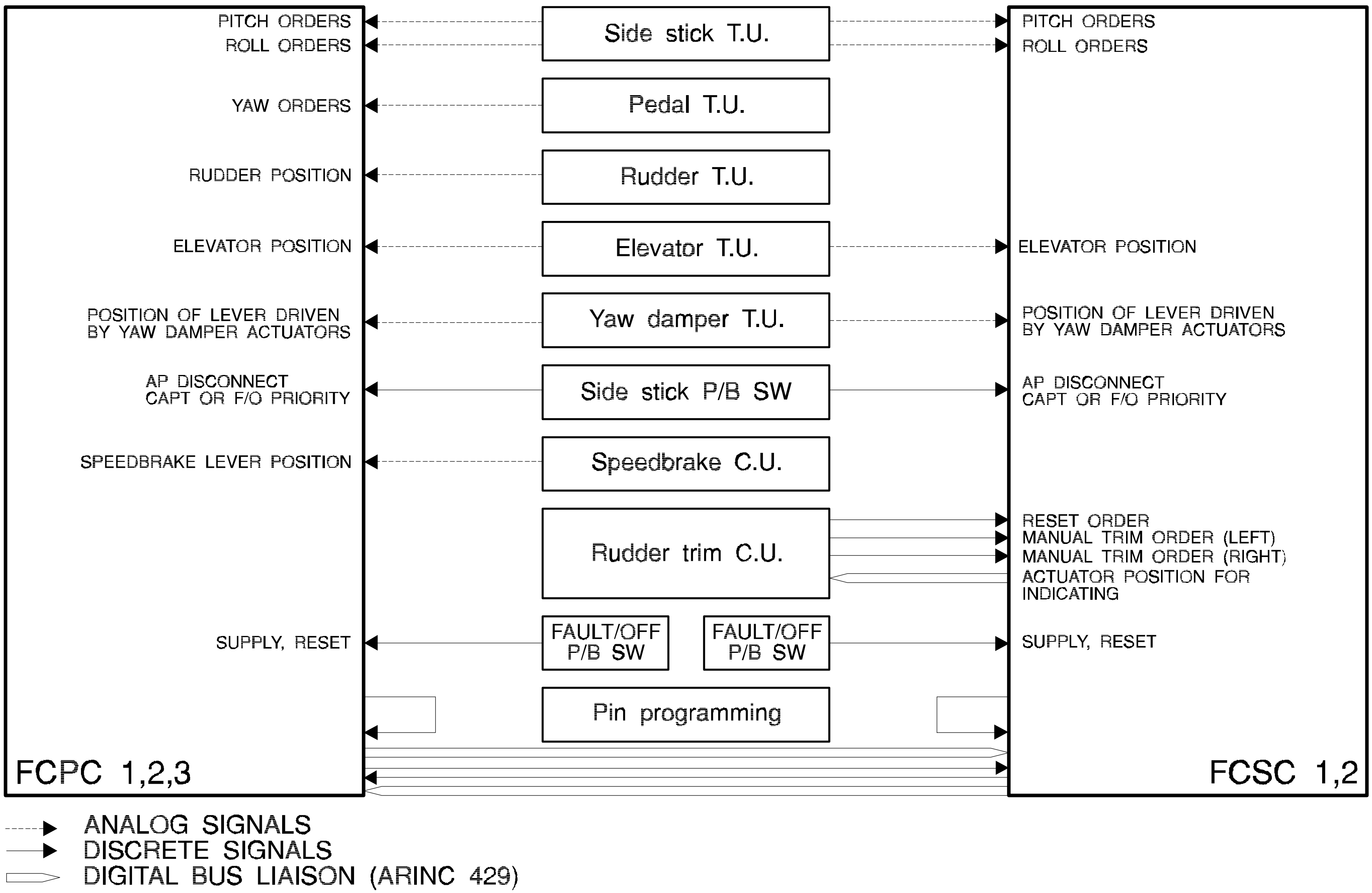
PUSHBUTTON SWITCHES

The side stick pushbutton switches transmit the Autopilot (AP) disconnect orders and side stick priority to the FCPCs and FCSCs.
The fault/off pushbutton switch liaisons supply and reset the computers.

PIN PROGRAMMING AND CROSS LINK

Each computer has an installation and an operation mode coding input.
The first enables the computer to distinguish where it is installed in position 1, 2 or 3.

The second enables the computer to distinguish between different operation modes, which are Aircraft (A/C) versions.
Each computer accepts data inputs from the others through a cross talk data link.



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SERVOCONTROL AND ACTUATORS

The computers transmit the deflection orders to each Actuator or Servocontrol and receive the servoloop feedback

In addition, they supply the solenoid valves and receive mode selector valve position and differential pressure information.

TRAVEL LIMITATION UNIT (TLU) AND RUDDER TRIM ACTUATOR (RTA)

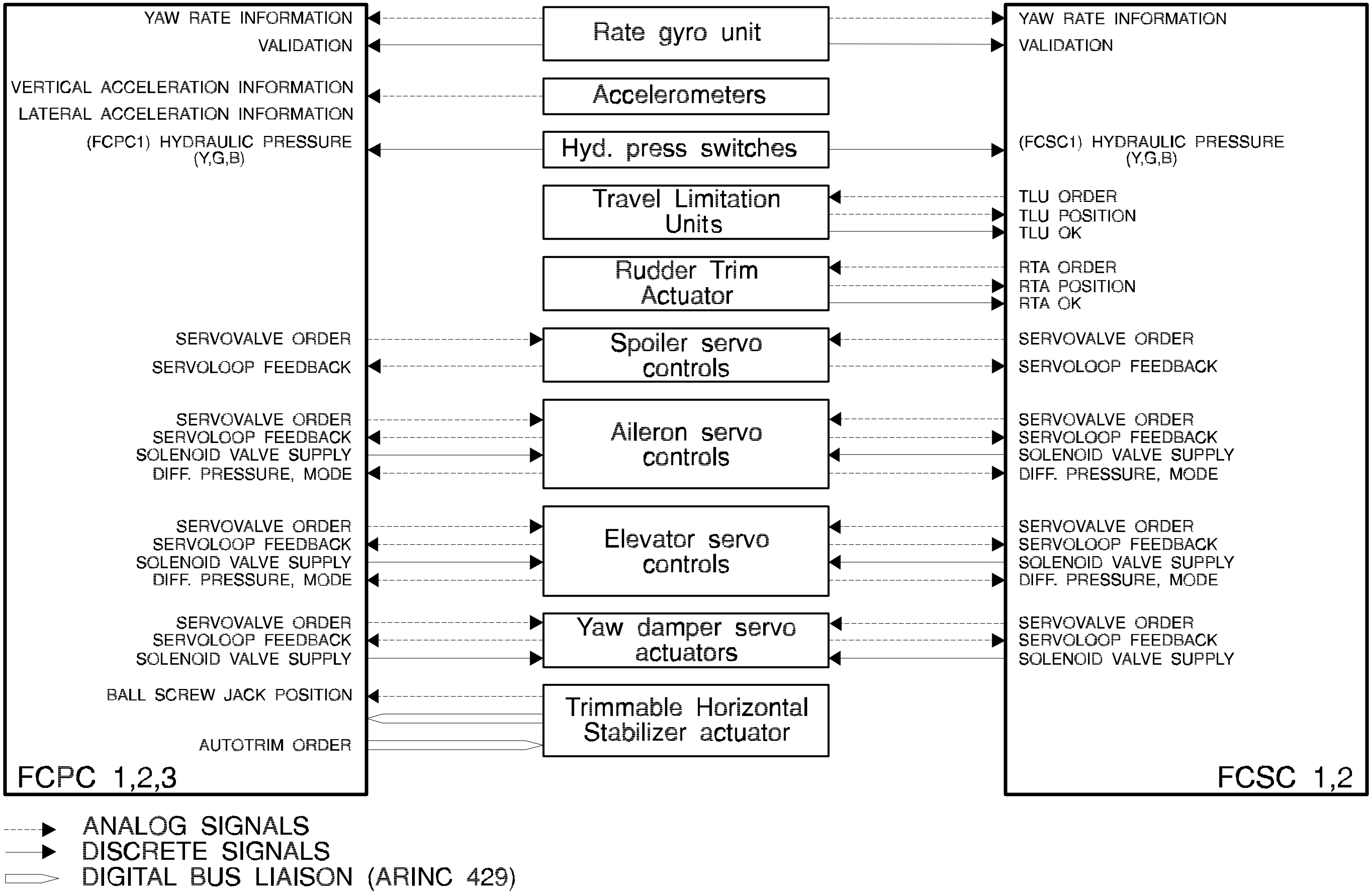
The FCSCs receive the Travel Limitation Units (RTLU and PTLU) and Rudder Trim Actuator (RTA) position for indication on the ECAM page and transmit the TLU order in function of Vc and RTA order.

RATE GYROMETERS AND ACCELEROMETERS

The Rate Gyrometers and the vertical Accelerometers transmit, in back up, the yaw rate and the vertical acceleration information to the Flight Control Primary Computers.
The lateral Accelerometers send the lateral acceleration used in the turbulence damping function to the FCPCs.

HYDRAULIC PRESSURE SWITCHES

The Hydraulic Pressure Switches transmit the hydraulic pressure to FCPC1 and FCSC1 for the servoing reconfiguration in case of hydraulic failure.



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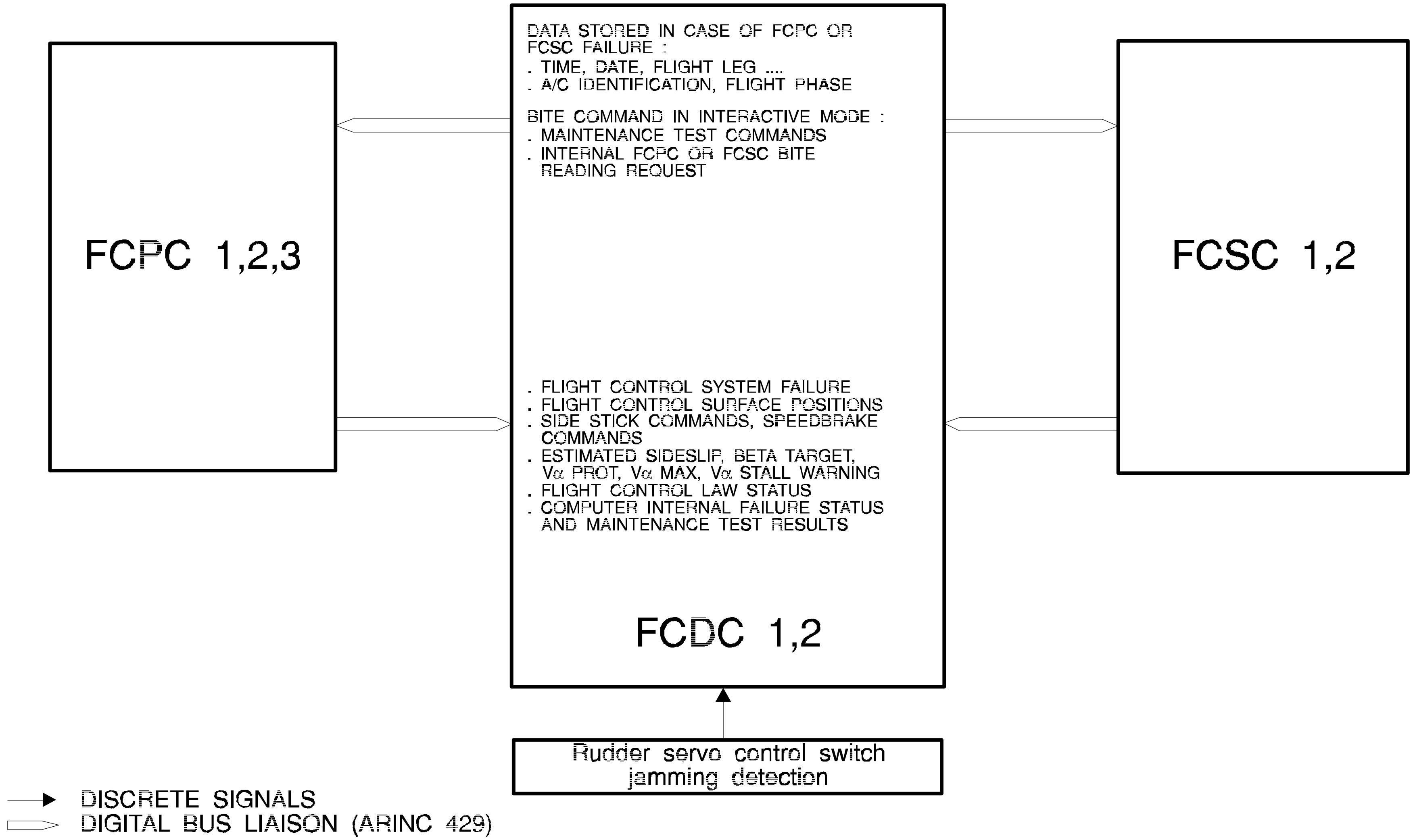
FLIGHT CONTROL DATA CONCENTRATOR (FCDC)

The Flight Control Data Concentrators (FCDCs) receive the rudder servocontrol jamming information to elaborate the corresponding warning.

Data is exchanged between FCDCs and FCPCs or FCSCs for data concentration, warning transmission and flight control system maintenance.



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STUDENT NOTES

SLATS AND FLAPS SYSTEM PRESENTATION

GENERAL

The high lift system includes two trailing edge flaps and seven leading edge slats on each wing. The surfaces are numbered from the wing root to the wing tip.
Position of the surfaces is selected from a control lever which transmits the demand to the Slat Flap Control Computers through a Command Sensor Unit.
The SFCCs, which are identical, ensure the control and monitoring of the slat and flap system. On lever demand, the SFCCs send signals to the Power Control Units to energize the valve blocks.
Two hydraulic motors in each Power Control Unit provide hydraulic actuation. Each of them is powered by a different hydraulic system and has its own valve block and pressure off brake.
The valve blocks control the direction of rotation and the speed of their related PCU output shaft.
The hydraulic motors move the transmission through a differential gearbox. Then torque shafts and gearboxes transmit the mechanical power to the actuators which drive the surfaces.
Wing tip brakes are provided in order to stop and lock the system when certain types of failure are detected.
Feedback signals sent by dedicated Position Pick-off Units are used by the computers to control and monitor the system.
A Feedback PPU provides signals concerning the PCU output shaft position, while two Asymmetry PPUs send information about surface actual position.
In addition signals sent from an Instrumentation PPU are used for position indicating on the ECAM.

SLAT / FLAP LEVER

Slat and flap positions are simultaneously selected using a single control lever located on the center pedestal (panel 114 VU).
Moving the lever rotates the input shaft of the Command Sensor Unit which translates the mechanical demand into electrical signals for the SFCCs.

SLAT / FLAP CONTROL COMPUTERS

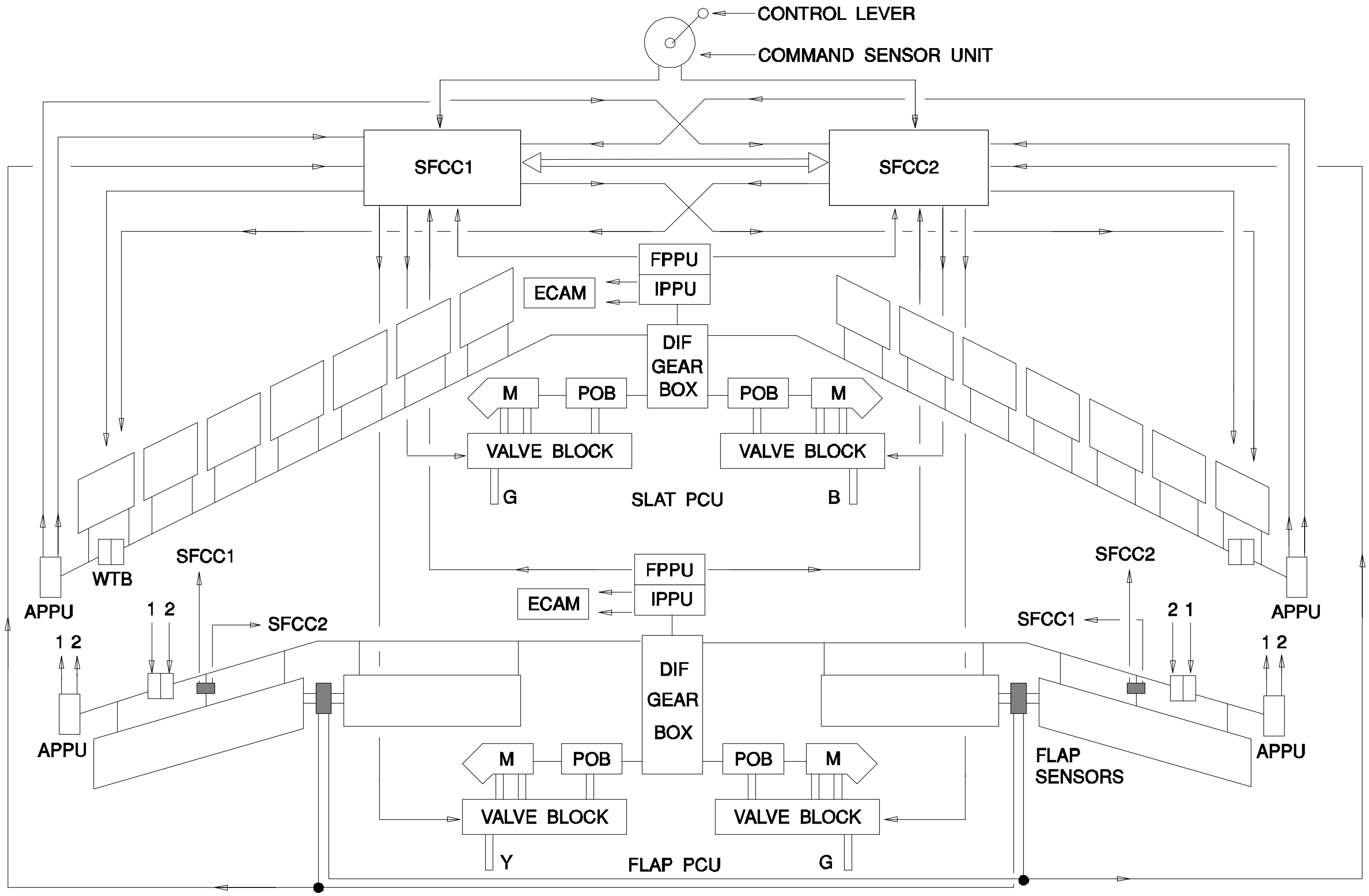
Two Slat Flap Control Computers control and monitor the system.
Each SFCC includes one slat and one flap channel.
A cross talk allows transfer of data between the SFCCs.
On lever demand, each channel generates commands to energize its associated PCU valve block and control its related motor.
The computers monitor the slat and flap drives and lock the appropriate channel, should a critical failure occur.
With one SFCC inoperative, both slat and flap systems operate at half speed.
The SFCCs also inhibit slat retraction from position 1 to 0 at high angle of attack and/or low speed (alpha-lock function).

POWER CONTROL UNITS

Each PCU incorporates two separate hydraulic motors powered through an electrically signalled valve block which receives drive commands from the SFCCs.
The motor output shafts on each PCU are coupled through a differential gearbox to drive the slat and flap mechanical transmission.
A Pressure Off Brake on each motor locks the transmission

- when the selected position is reached
- when there are no drive commands
- or in case of hydraulic power failure.

If one motor is inoperative, (i.e hydraulic failure or SFCC failure), the remaining motor provides full output torque at half speed.



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POSITION PICK-OFF UNITS

The SFCCs monitor surface operation through dedicated Position Pick-off Units.
One Feedback and one Instrumentation PPU are mounted on each PCU.
One Asymmetry PPU is installed at the end of the transmission system on each wing.
The Instrumentation PPUs provide slat/flap actual position data for indication on the ECAM through the Flight Warning Computer.
The Asymmetry and Feedback PPUs are used to monitor asymmetry, runaway or overspeed conditions.

- Asymmetry is detected on disagreement between the two APPU signals.
- Runaway is detected by comparison of both APPU and FPPU signals.
- Overspeed is detected when overspeed of one or more PPUs occurs due to high aerodynamic loads acting in the same direction as the transmission.

WING TIP BRAKES

The Wing Tip brakes are of the pressure-off type.
They are released when hydraulic and electrical power is applied.
The Wing Tip Brakes stop and hold the transmission if the SFCCs detect certain types of failures such as asymmetry, runaway or overspeed.
Each WTB is equipped with two solenoid valves each controlled by one SFCC and supplied by one hydraulic system.
In normal flight conditions, the solenoids are permanently energized.
The segregation of the two hydraulic circuits results in either one being able to keep the brake released.
They are conceived as pressure off type brakes so that a pressure peak doesn't lead to their application.
With one SFCC inoperative, the second one still enables the brake to be kept released.
Flap locking by the WTB does not prevent slat operation and vice versa.
Once applied, the WTB can be reset on ground via the Centralized Maintenance System only.

FLAP SENSORS

A flap disconnect detection system inhibits further flap operation when a flap attachment failure is detected.
It consists of two sensor assemblies on each wing, which measure excessive differential movement between inner and outer flaps.

- One electrically controlled, mechanically actuated sensor unit including two sensors is installed on the flap interconnecting strut.
- A second sensor unit is located at flap track four.

If a flap disconnect is detected, the flap PCU is de-energized and the Pressure Off Brakes are applied in order to stop the transmission. Further flap operation is inhibited.

STUDENT NOTES:.

STUDENT NOTES

SLAT DRIVE PRESENTATION

Power Control Unit
Gearboxes
Torque Limiters
Torque Shafts
Rotary Actuators
Slat Tracks
Typical Installation

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POWER CONTROL UNIT

The slat PCU drives the slat transmission system via a single output shaft. The PCU incorporates two differentially coupled hydraulic motors supplied by two separate hydraulic sources via two individual electrically supplied valve blocks.
Command signals from the SFCCs operate and control the solenoid valves of the valve blocks in order to provide the right direction and speed of rotation. Movement of the main control valve spool and release of the hydraulically operated Pressure-Off-Brake allow powered movement of the PCU output shaft.
If one motor is inoperative, the remaining one provides full output torque but the transmission system is driven at half of the normal operation speed.

GEARBOXES

A T gearbox installed in front of the wing center box provides output torque from the power control unit to the left and right wings.
The T gearbox has a ratio of 1.3/1 .
The input and output shafts have splines which connect them to the transmission system. An inspection hole is provided for the inspection of bearings.
Two identical right angle gearboxes installed in each wing root are provided to accomodate a 90º change in direction in order to achieve correct orientation.
The right angles gearboxes have a ratio of 1/1.
The input and output shafts have splined ends for connection to the torque shafts. Inspection holes are provided for the inspection of bearings.
One 53° bevel gearbox per wing is attached to the fuselage adjacent to the wing root and aligns the transmission with the wing leading edge.
The 53° bevel gearbox has a ratio of 1/1.
The input and output shafts have splined ends for connection to the torque shafts. Inspection holes are provided for the inspection of bearings.

TORQUE LIMITERS

In order to prevent too much load from being transmitted to the structure, a system torque limiter is installed in the torque shaft assemblies between the T gearbox and the right angle gearboxes.
A lockout indicator senses relative motion between the input and output shafts and pops out when an overtorque occurs.
In addition, torque limiting devices are fitted in each actuator to protect the aircraft structure against excessive torque that may be generated during a system locking or jamming.
The torque limiter transmits the torque from the input shaft to the sun gear of the actuator. An indicator pops out to show if lock out has occurred.

TORQUE SHAFTS

The gearboxes and actuators are driven from the PCU by the torque shafts which are connected through universal joints and supported in steady bearings.
The universal joints permit small angular changes of alignment.

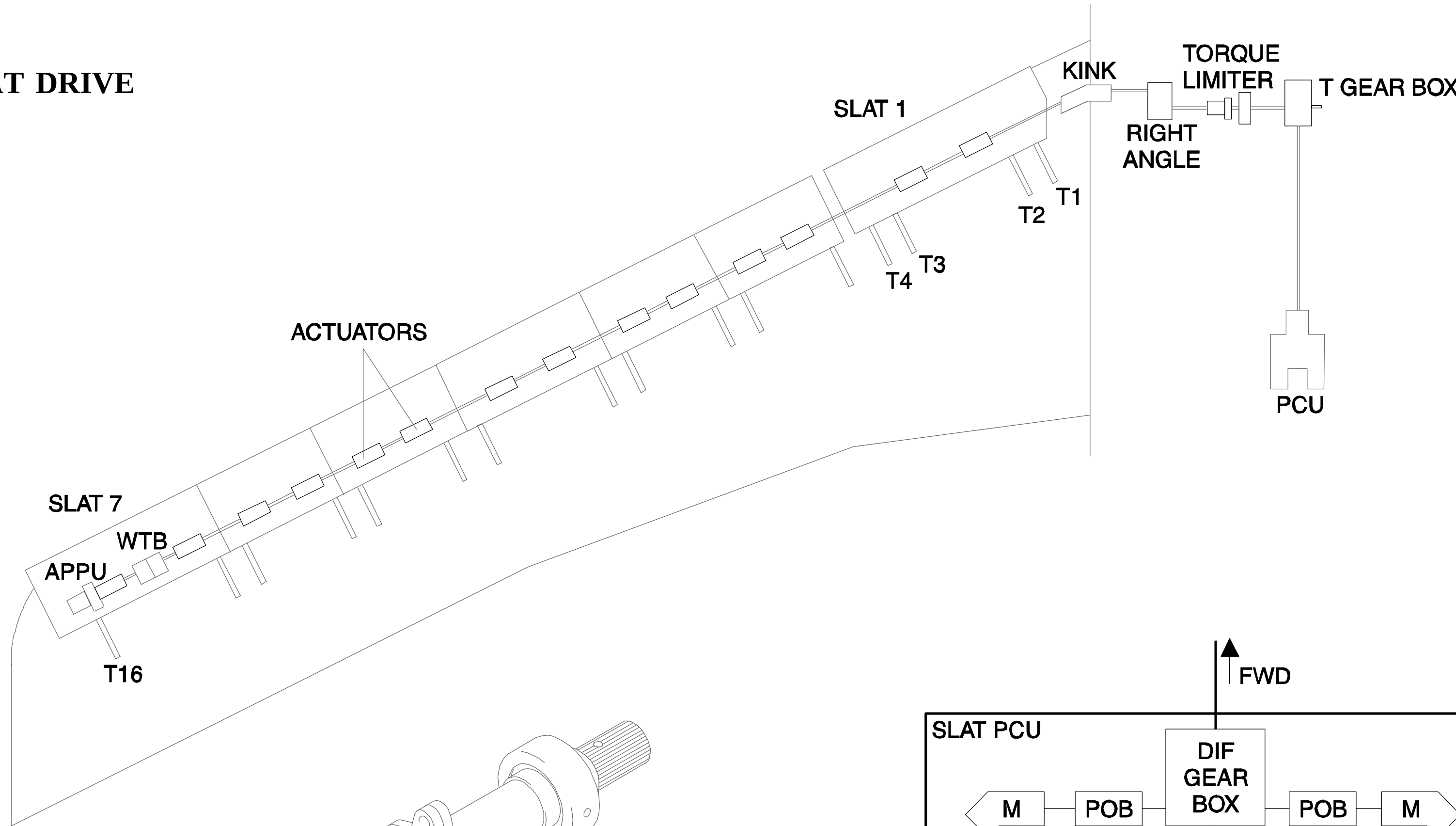
ROTARY ACTUATORS

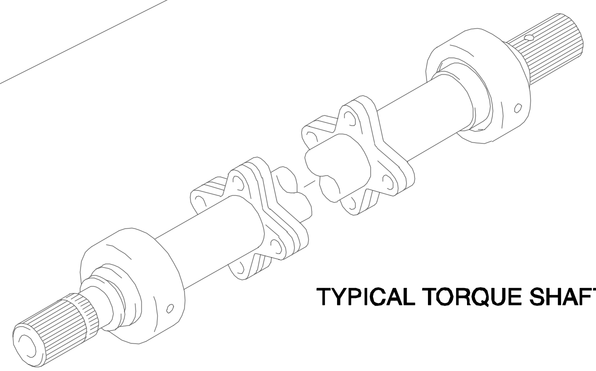
Movement of the slats is performed through rotary gear actuators attached to the fixed leading edge structure. There are two types of actuators.
Type A actuators incorporate larger gears and an additional gear train by virtue of the greater loads applied on slat 1. They are installed on tracks 2 and 3.
The actuators provide the required torque and decrease the speed to drive the tracks that support the slats.
The other actuators are refered to as type B actuators. The connection of type A and B actuators to the tracks is different. Each actuator is fitted with a torque limiter assembly.

SLAT TRACKS

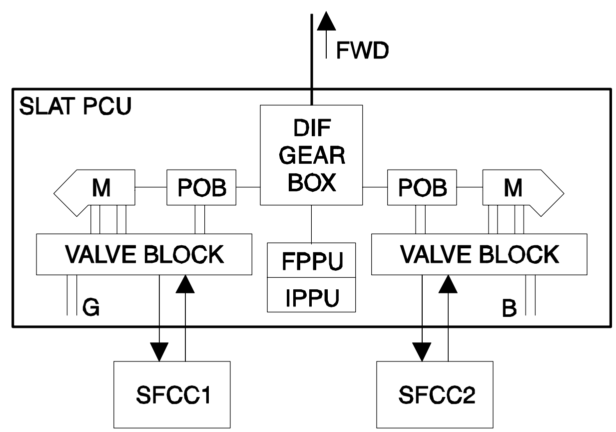
Slat 1 is supported by four tracks but only tracks 2 and 3 are driven. Slats numbers two to seven are supported by two driven tracks.
All tracks are guided in vertical-load and side-load rollers.
The tracks are of inverted U section type. They retract through holes in the front spar into a sealed container which makes a projection into the fuel tank.

SLAT DRIVE





TYPICAL TORQUE SHAFT



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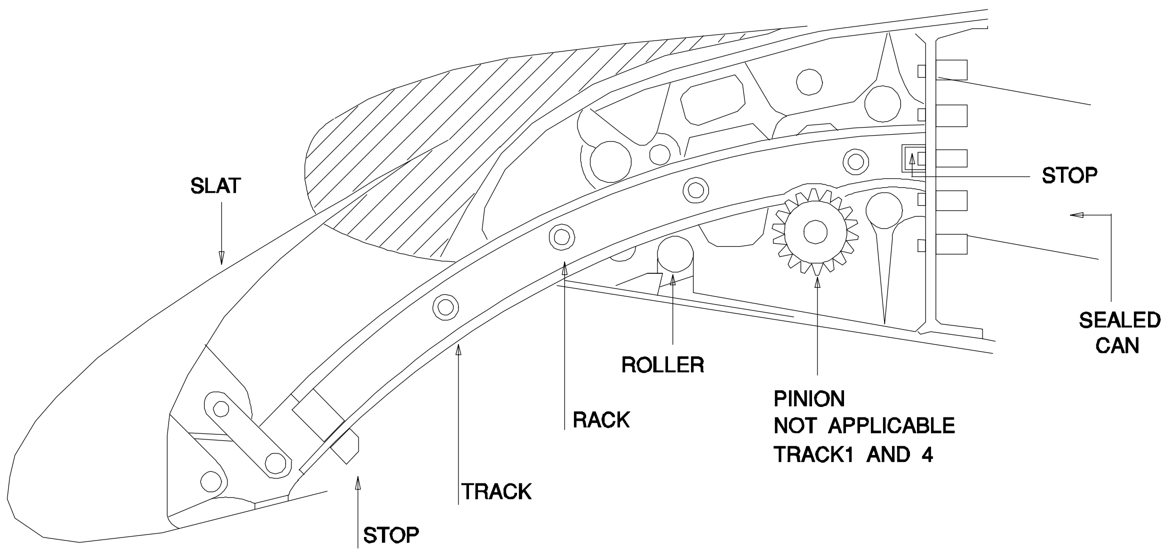
TYPICAL INSTALLATION

This typical installation is only valid at tracks 5 thru 16.
The track is operated through a rack and pinion mechanism driven by the actuator output shaft. At tracks 2 and 3 the rack and pinion device is replaced by an output bellcrank and a rod.

TYPICAL INSTALLATION



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STUDENT NOTES:

FLAP DRIVE PRESENTATION

Power Control Unit
Gearboxes
Torque Limiters
Torque Shafts
Drive Stations
Flap Tracks
Typical Installation

POWER CONTROL UNIT

The flap PCU drives the flap transmission system and transmits power through the torque shafts down to the Wing Tip Brakes.
The PCU incorporates two differentially coupled hydraulic motors, supplied by two separate hydraulic sources via two individual electrically supplied valve blocks.
Command signals from the SFCCs operate and control the solenoid valves of the valve blocks in order to provide the right direction and speed of rotation.
Movement of the main control valve spool and release of the hydraulically operated Pressure-Off-Brake allow actuation of the motor torque shaft.
If one motor is inoperative, the remaining one provides full output torque but the transmission system operates at half of the normal operation speed.

GEARBOXES

Two identical right angle gearboxes are provided to achieve correct orientation in the wing root area.
Each right angle gearbox has a shaft angle of 90º and a 1/1 ratio.
The input and output shafts have splined ends for connection to the torque shafts. The gearbox is sealed and grease lubricated and is provided with inspection plugs.
A kink bevel gearbox is installed between tracks 2 and 3 to achieve the required change in direction of the transmission. It also reverses the direction of rotation of the transmission.
The kink bevel gearbox has a shaft angle of 21º and a 1/1 ratio.
The input and output shafts have splined ends for connection to the torque shafts. The kink bevel gearbox is sealed and grease lubricated and is provided with inspection plugs.

TORQUE LIMITERS

To prevent too much load from being transmitted to the structure, a system torque limiter installed upstream of the right angle gearboxes protects the transmission from overtorque.
A lockout indicator senses relative motion between the input and output shafts and pops out when an overtorque occurs.
In addition, a torque limiting device is fitted into each actuator to protect the downstream components from overtorque.
Each torque limiter is set with its individual lock out torque value. A latch type indicator shows if a lock out torque has occurred.

TORQUE SHAFTS

The torque shafts are designed to transfer the torque from the PCU to the drive stations via the gearboxes. They are connected through universal joints. The universal joints permit small angular changes in alignment.

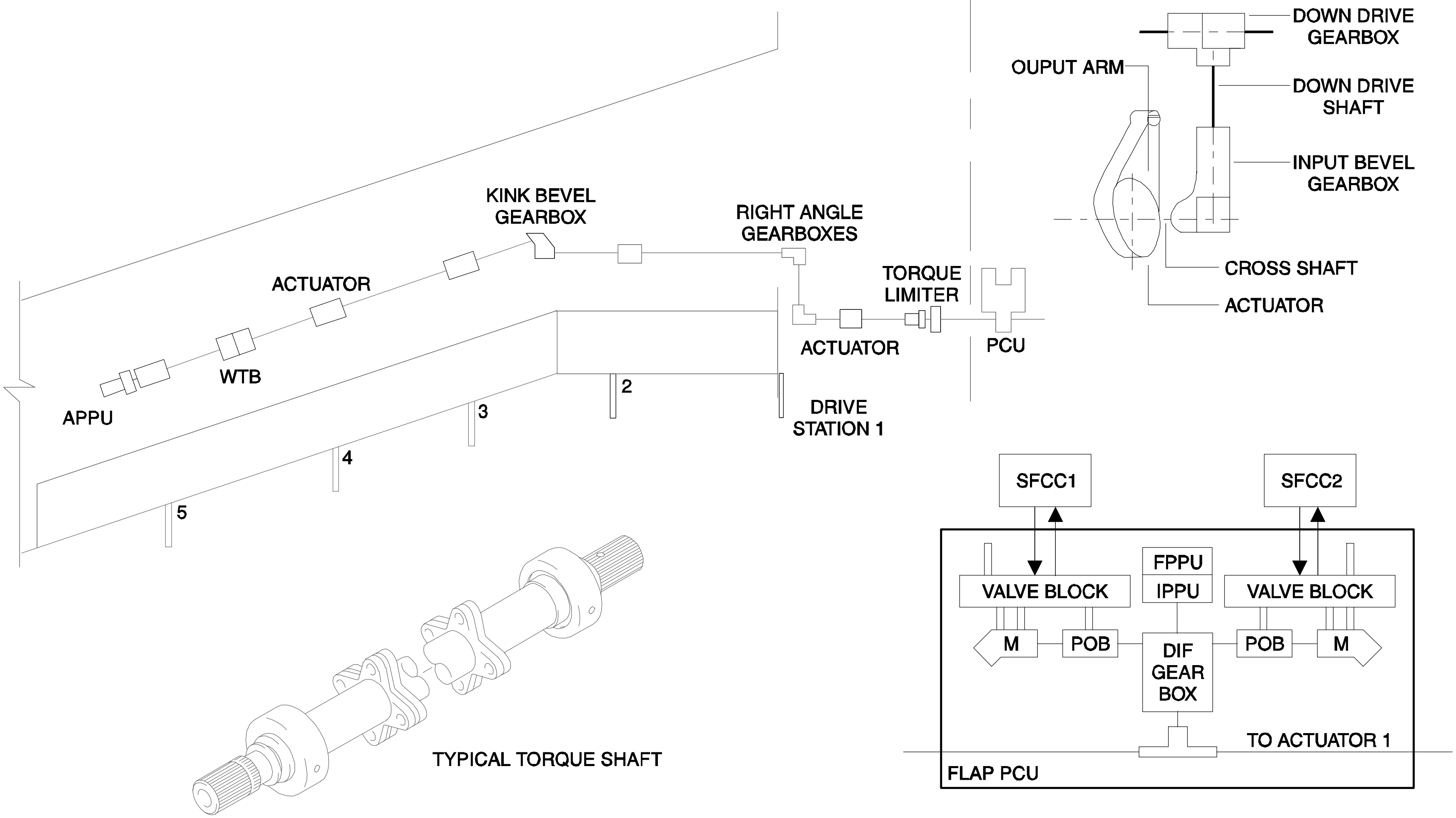
DRIVE STATIONS

Two drive stations for the inner flap and three for the outer flap, each includes:

- a down drive gearbox,
- a down drive shaft,
- an input bevel gearbox,
- a cross shaft,
- and a rotary actuator.

Each input bevel gearbox is fitted with a torque limiter which operates in both directions. The reduction ratio rotary actuators mounted on the track beams drive the flaps.
The down drive gearbox transfers the power from the torque shafts to the input bevel gearbox via the down drive shaft. Power is then transmitted from the input gearbox to the actuator through the cross shaft.
Two types of rotary actuators are used:
- Type A is installed on drive stations 1 and 5.
- Type B which is larger is installed on stations 2 thru 4 because of high aerodynamic loads at these points.
Each actuator has an output arm connected to the flap drive linkage.

FLAP DRIVE



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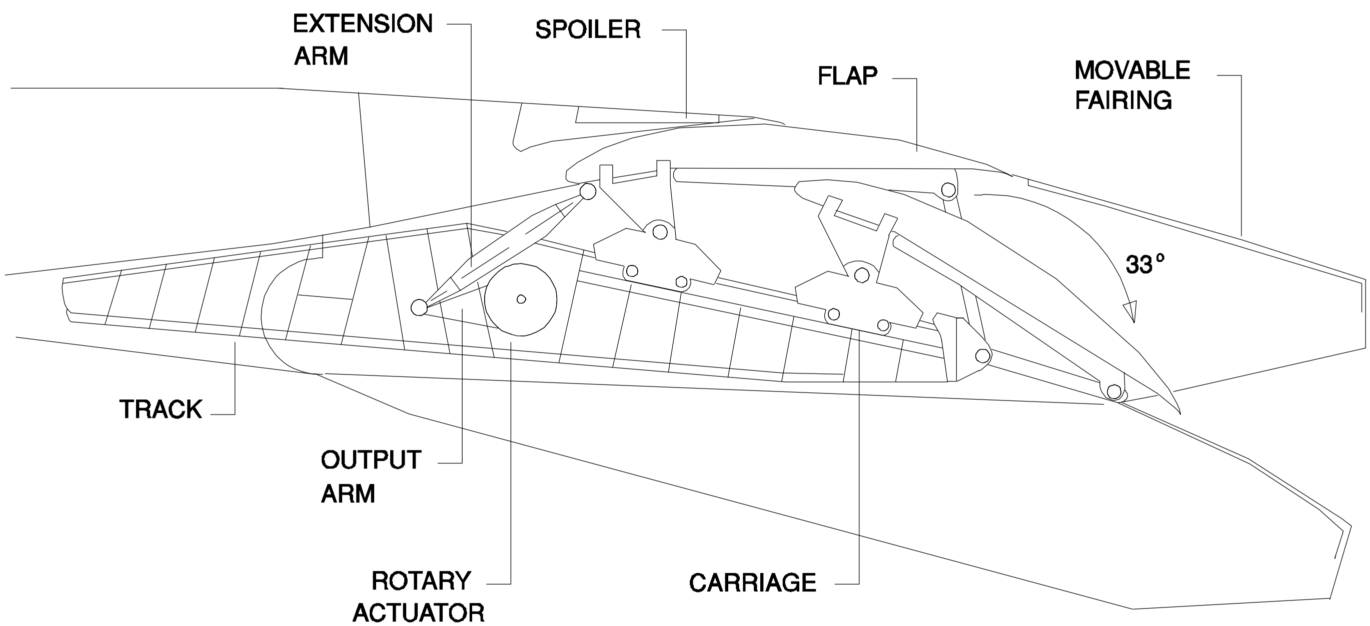
FLAP TRACKS

The flaps are supported on carriages travelling on straight tracks.
The inboard flap is supported on 2 tracks, the outer one on three.
The tracks are connected, with drive arms, to the carriages.
They are of a similar construction except track 1 which is attached to the fuselage.

TYPICAL INSTALLATION

Extension arms, extending from the flap leading edge, are connected to the output arms of the rotary actuators.
The rotary actuator output arm operates the flap through an extension arm.
The flap is guided by carriages running in the track.
The actuator and output arm form an integrated assembly mounted directly to the flap track beam.

DESIGN PRINCIPLE FOR TRACKS 3 AND 5



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STUDENT NOTES:

ECAM PAGE PRESENTATION

Wing Fixed Part
Moving Indexes
Slat/Flap Positions
Target Positions
Side Indications
Config indication
Invalid Information

Wing Fixed Part

A grey symbol represents the wing fixed part.
This grey symbol is permanently displayed.

Moving Indexes

The S/F actual positions are symbolized by green indexes moving in either direction (extension or retraction) according to the movement of the surfaces.
In clean configuration, these moving indexes are located on each side of the grey wing fixed part.
The indexes can have two states according to the configuration :

they are displayed green in normal operation,
they are displayed amber in case of :

- relevant hydraulic system loss
- wing tip brake application (slats and/or flaps locked)
- slats and/or flaps fault.

Slat/Flap Positions

White dots indicate the theoritical possible slat flap positions.
They are not displayed in clean configuration.

Target Positions

When a new Slat/Flap configuration is selected, cyan dots become visible below the slat and flap demanded position.
They symbolize the target position and can have two states :

- the cyan dot appears below the selected position and remains as long as the moving indexes are in transit
- the cyan dot disappears as soon as the selected position is reached by the surfaces.

Side Indications

S and F letters indicate the front and rear part of the wing and the slat and flap side.
They can have three different states according to the configuration :

they are not displayed in clean configuration,
they are displayed white in normal configuration,
the concerned S or F white letter changes to amber in case of :

- relevant hydraulic system loss
- wing tip brake application
- slats and /or flaps fault.

Config indication

Numbers or letters indicate the selected configuration.
These selected positions can be : 0, 1, 1+F, 2, 3 and FULL.
The indication has two states:

- the config indication is displayed cyan as long as the surfaces are in transit
- the config indication is displayed green as soon as the actual position reaches the selected configuration.

The cyan 0 representation, corresponding to S/F moving from 1 to fully retracted, goes out as soon as position 0 is reached and the clean configuration is displayed.

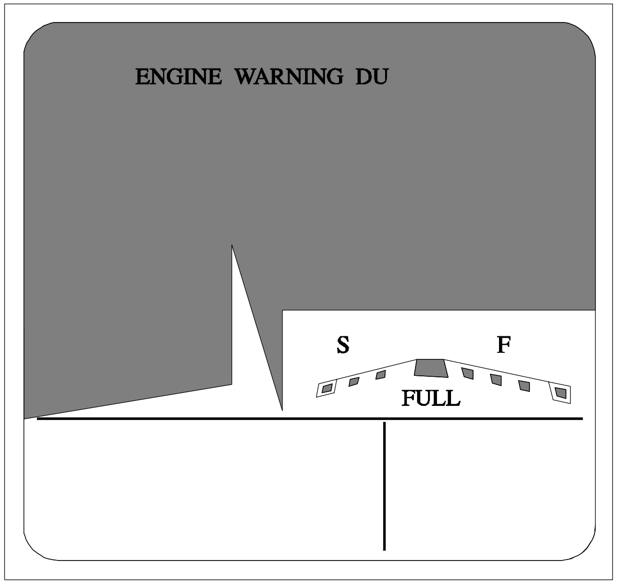
Invalid Information

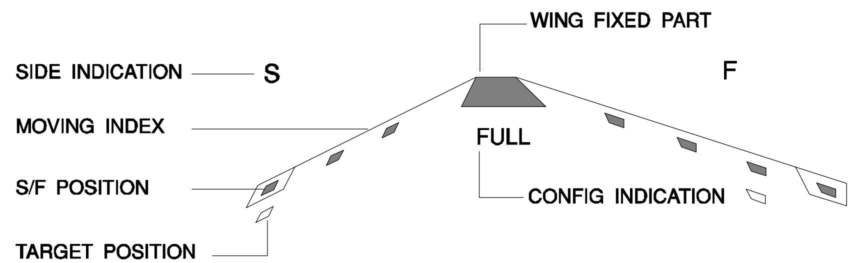
Invalid means that data can’t be properly displayed.
Invalid position data :

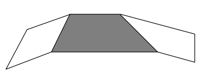
- the dot and index of the concerned side are removed and replaced by two amber crosses XX while the corresponding side letter changes from white to amber.

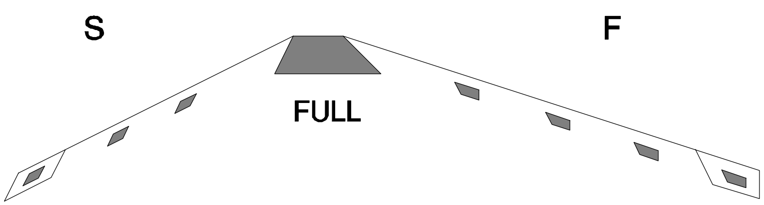
Invalid configuration indication :

- in such a case, with no valid data available, the configuration indication is replaced by two amber crosses XX.

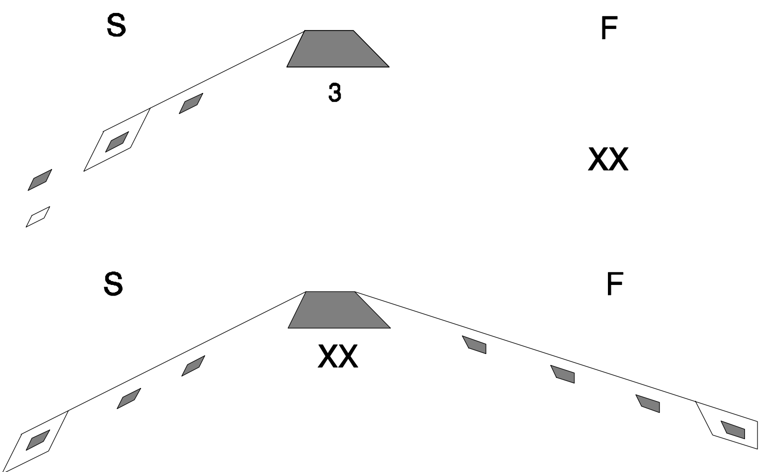








INVALID INFORMATION



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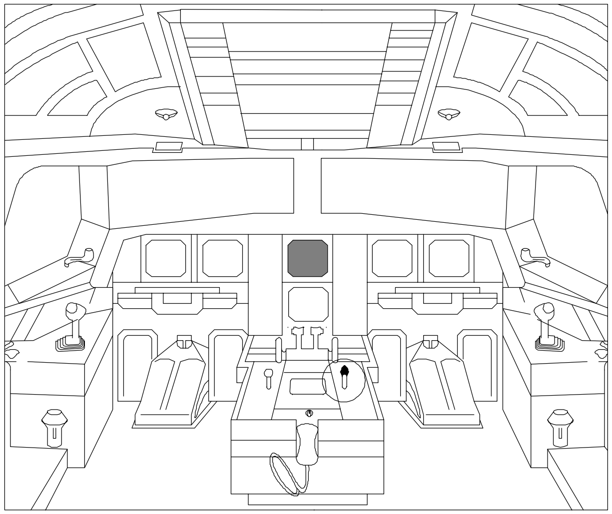
STUDENT NOTES

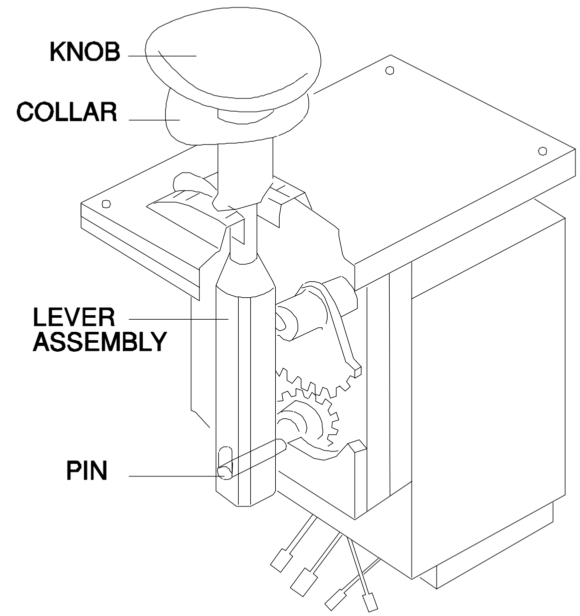
CONTROL LEVER OPERATION AND POSITION INDICATING

SLAT FLAP CONTROL LEVER

The Slat Flap control lever is located in the cockpit on the center pedestal (panel 114VU).
It is connected to the Command Sensor Unit which transforms the mechanical demand into electrical signals for the SFCCs.
The lever selects simultaneous operation of the slats and flaps and must be pulled out of the detent before selection of any position.
The relationship between the lever position, flight phase and slat flap angles is shown here.



LEVER POSITION	FLIGHT PHASE
0	CRUISE
1	HOLD
1+F	TAKE OFF
2	T/O APPROACH
3	T/O APPR LDG
FULL	LANDING



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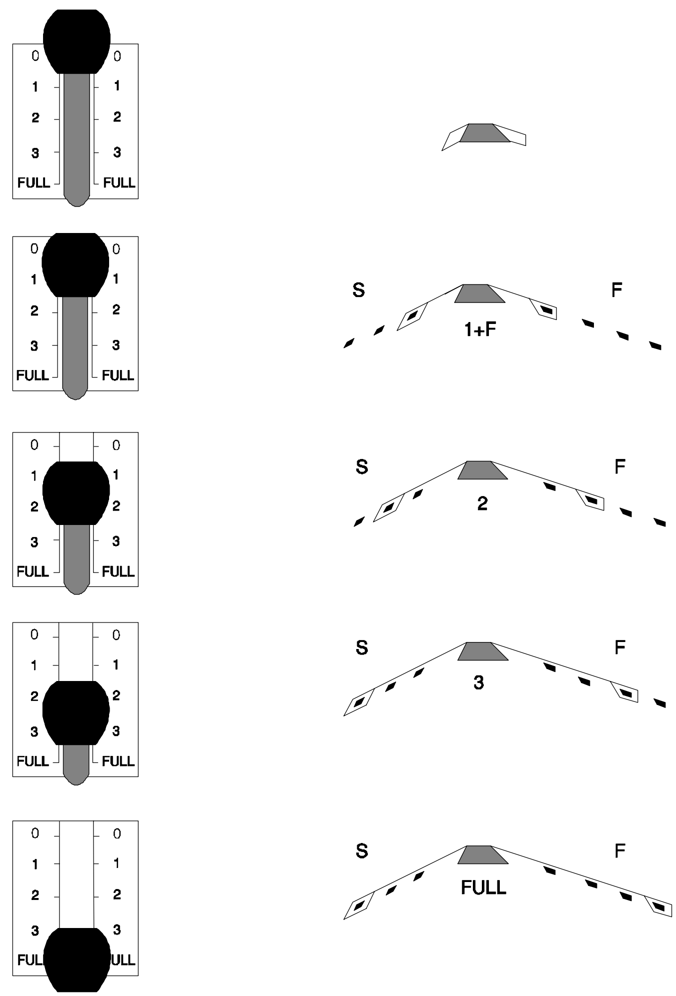
EXTENSION ON GROUND

On ground, when position 1 is selected, both slats and flaps extend. The take off configuration is 1+F.

RETRACTION ON GROUND

With the aircraft on ground, the configuration is 1+F.
Once the surfaces have reached the fully retracted position, the clean configuration is displayed on the ECAM.



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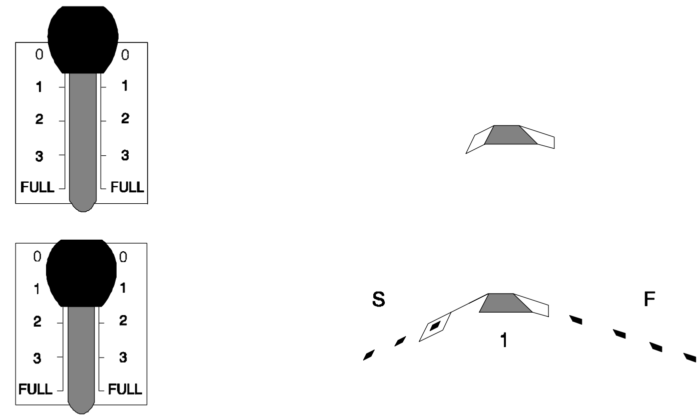
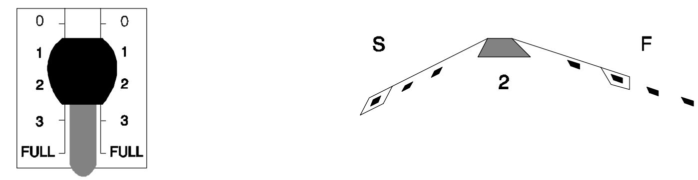
EXTENSION IN FLIGHT

In flight, when position 1 is selected, only slats extend.
For position 2, 3 and FULL, the deflection angles are the same as those mentioned for extension on ground.

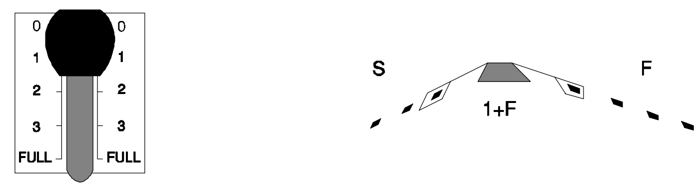


RETRACTION IN FLIGHT

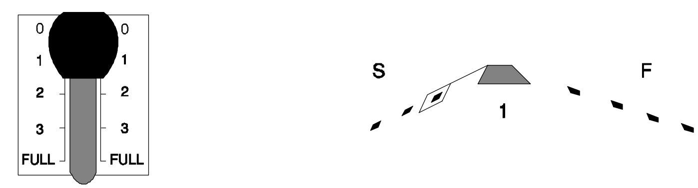
Retraction from fully extended, to position 3 and from position 3 to position 2 is identical to surface retraction on ground.
There are two configurations, depending on speed, for retraction to position 1 in flight.



- Speed below 200 kt:



- Speed above 200 kt:

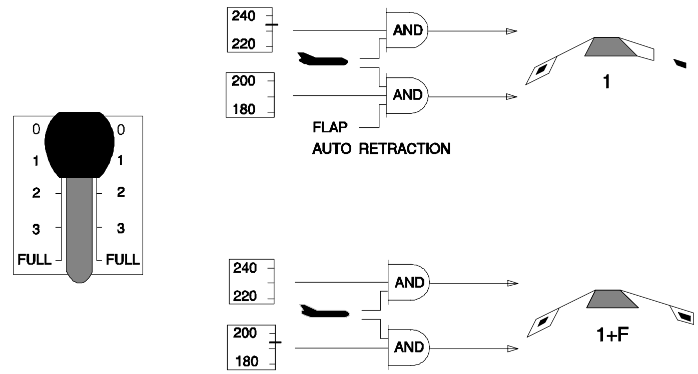


AUTOMATIC RETRACTION IN FLIGHT

The present speed is lower than 200 kt and the configuration is 1+F.
The flap auto function is engaged. When the computed airspeed reaches 200 kt, the flaps retract automatically to 0 and the new slat flap configuration is 1.
Note that, when take off is performed in config 1+F, flaps fully retract automatically at 200 kt if config 0 is not selected after take off.

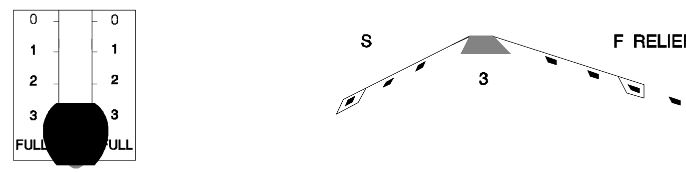
Speed below 200 kt - Config 1+F
Speed above 200 kt - Config 1

After an automatic flap retraction, there is no automatic re-extension if the speed drops below 200 kt.



FLAP RELIEF

The relief function limits flap surface extension to a relief angle as airspeed increases and exceeds VFE (Velocity Flap Extended).
When activated, the Flap Load Relief System retracts the flaps to the deflection corresponding to the lever position just below the present one.
In that case, a green pulsing F RELIEF message is displayed.
When the airspeed drops below VFE, the flaps surfaces automatically extend again to a larger angle.

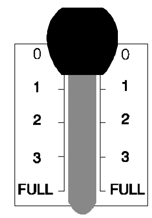


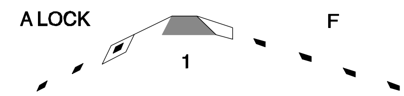
SLAT ALPHA LOCK

Slat retraction from position 1 to 0 is inhibited to prevent the aircraft from stalling when the angle of attack is high (alpha lock) or the speed is too low (slat baulk).
The slat channels of the SFCCs receive Corrected Angle Of Attack CAOA and computed airspeed CAS provided by the ADIRUs for use in alpha lock computation.
Slat retraction from position 1 to 0 is prevented if:
- CAOA > 8.5° or CAS < 148 kt
  A green pulsing A LOCK message is displayed to indicate the retraction inhibition.

The alpha lock function is reset if:
- CAOA < 7.6° or CAS > 154 kt

The function is not active if :
- the aircraft is on ground with CAS < 60 kt
- alpha exceeds 8.5° or CAS drops below 148 kt while retraction from position 1 to 0 has already started.





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STUDENT NOTES:

SLAT DRIVE STATION DESCRIPTION AND OPERATION

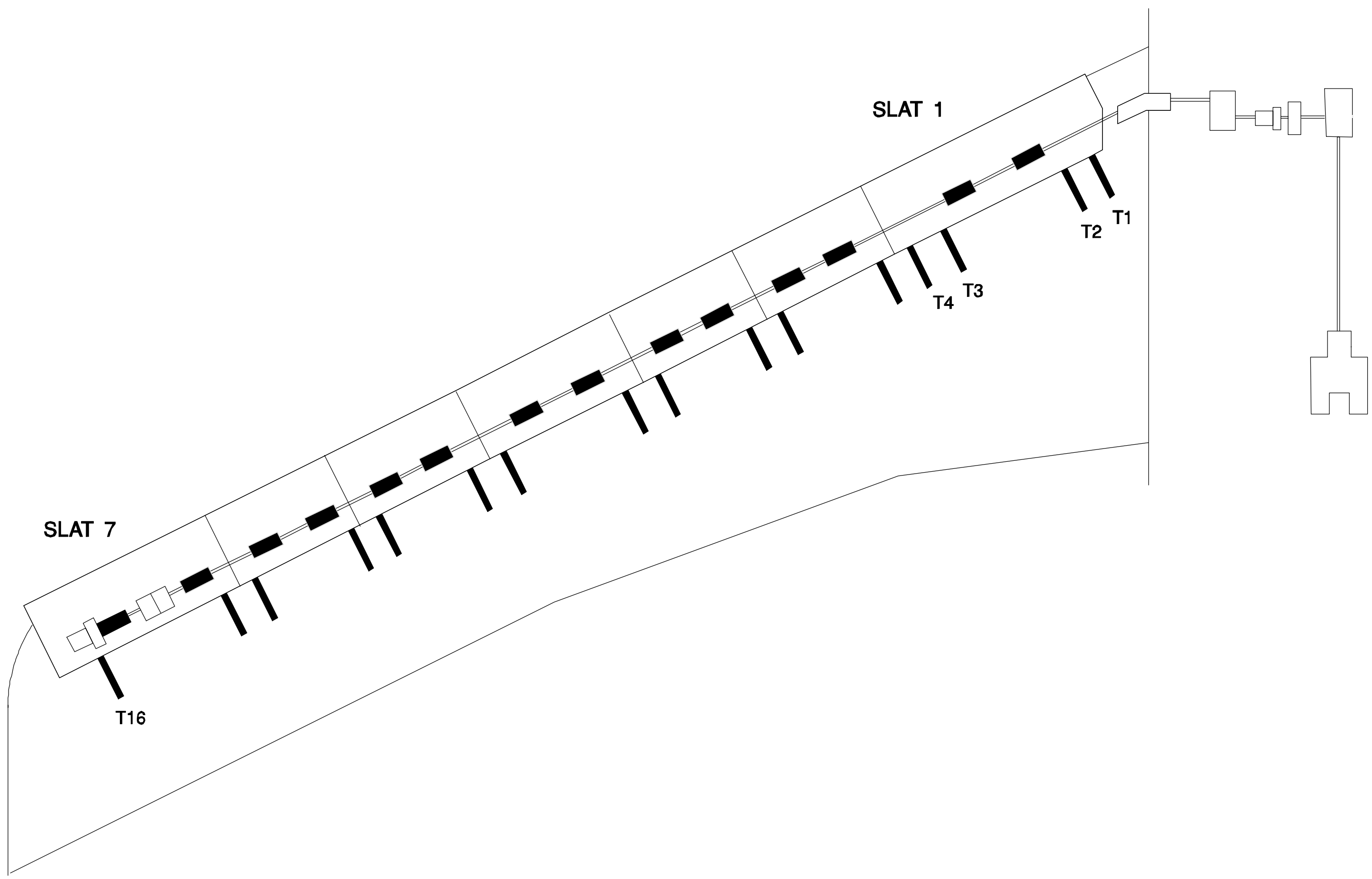
GENERAL

The leading edge of each wing is fitted with seven slat surfaces made of light alloy.

Each slat is supported by curved beams or tracks.

There are four tracks for the inner slat and two tracks for slats 2 thru 7. All tracks move in vertical-load rollers and have side-load rollers.

The actuators are installed on tracks 2, 3 and 5 thru 16.


SLAT 1
T1
T2
T3
T4
SLAT 7
T16

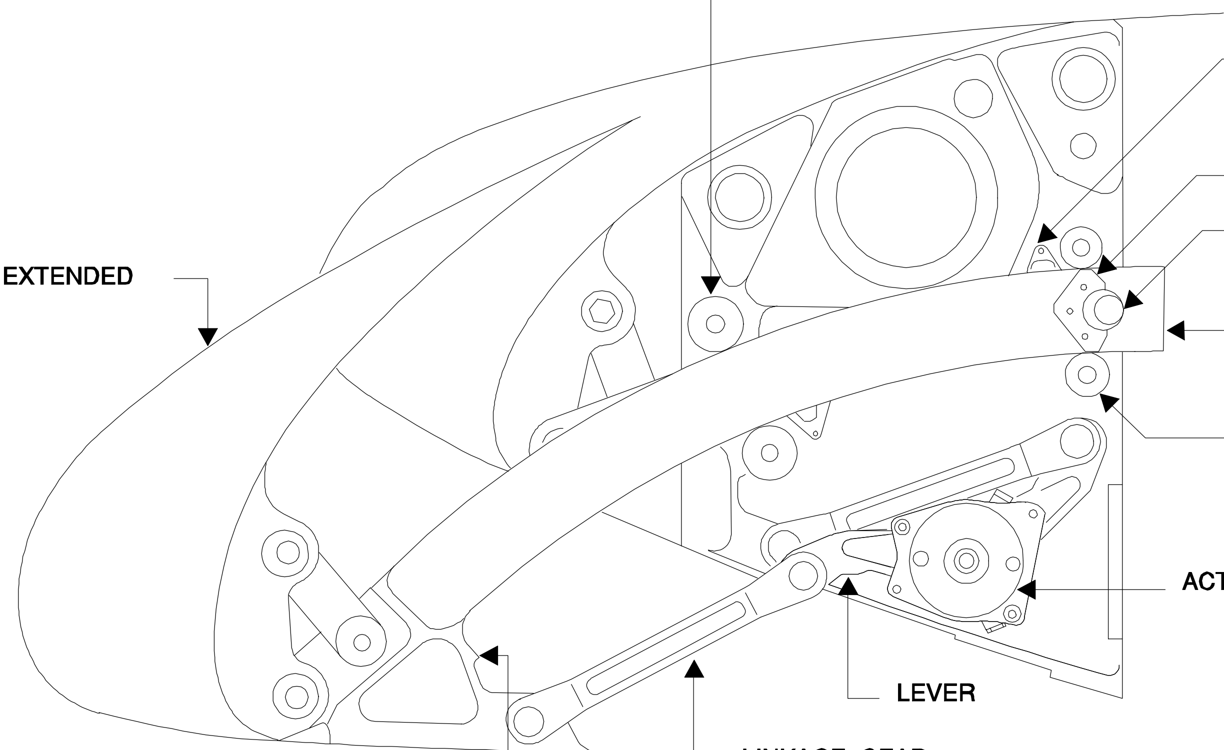
SLAT 1

Slat 1 tracks are of curved I-section.

At tracks 2 and 3, a lever and linkage gear assembly transmits the torque from the related actuators to the tracks.
The actuator output shafts move the levers.

Tracks 1 and 4 do not transmit mechanical power.

For aerodynamic purposes, a closing plate closes the cut-out between track and wing leading edge when the slat is retracted.



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SLAT 2 THRU 7

Tracks 5 thru 16 are of inverted U-section.

The track is operated through a rack and pinion mechanism driven by the actuator output shaft.

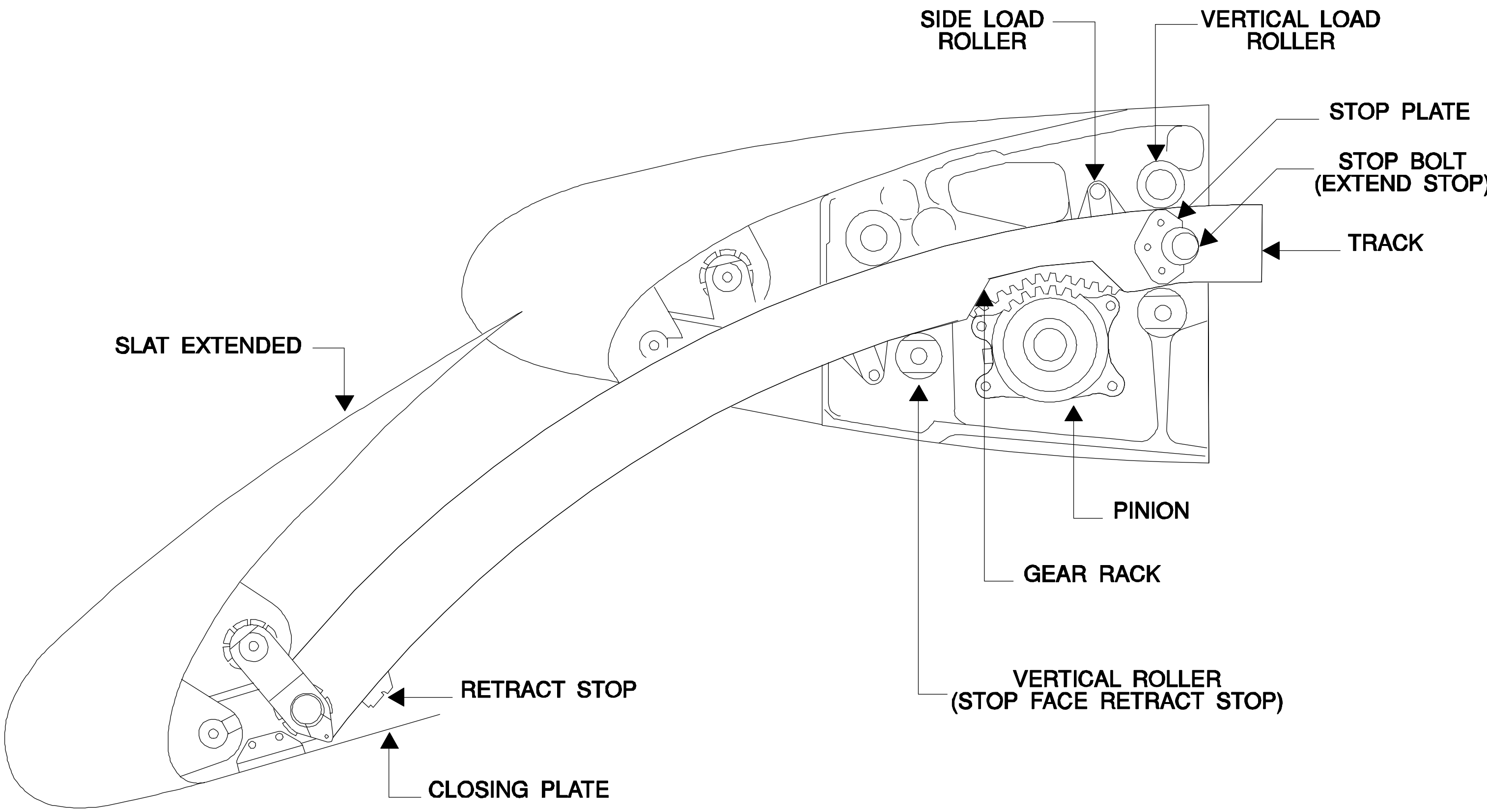
Bearings between the track rib support the pinion.

The rollers are installed on two track ribs attached to the forward face of the front spar.

The tracks retract through holes in the front spar into a sealed container which makes a projection into the fuel tank.

A fixed stop is installed at each end of the tracks which have actuators.
Closing plates are installed as for slat 1.

A gap between the lower vertical roller and the retract stop achieves slat zeroing.



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STUDENT NOTES

FLAP DRIVE STATIONS DESCRIPTION AND OPERATION

General
Drive Station 1
Drive Stations 2, 3, 5
Drive Station 4

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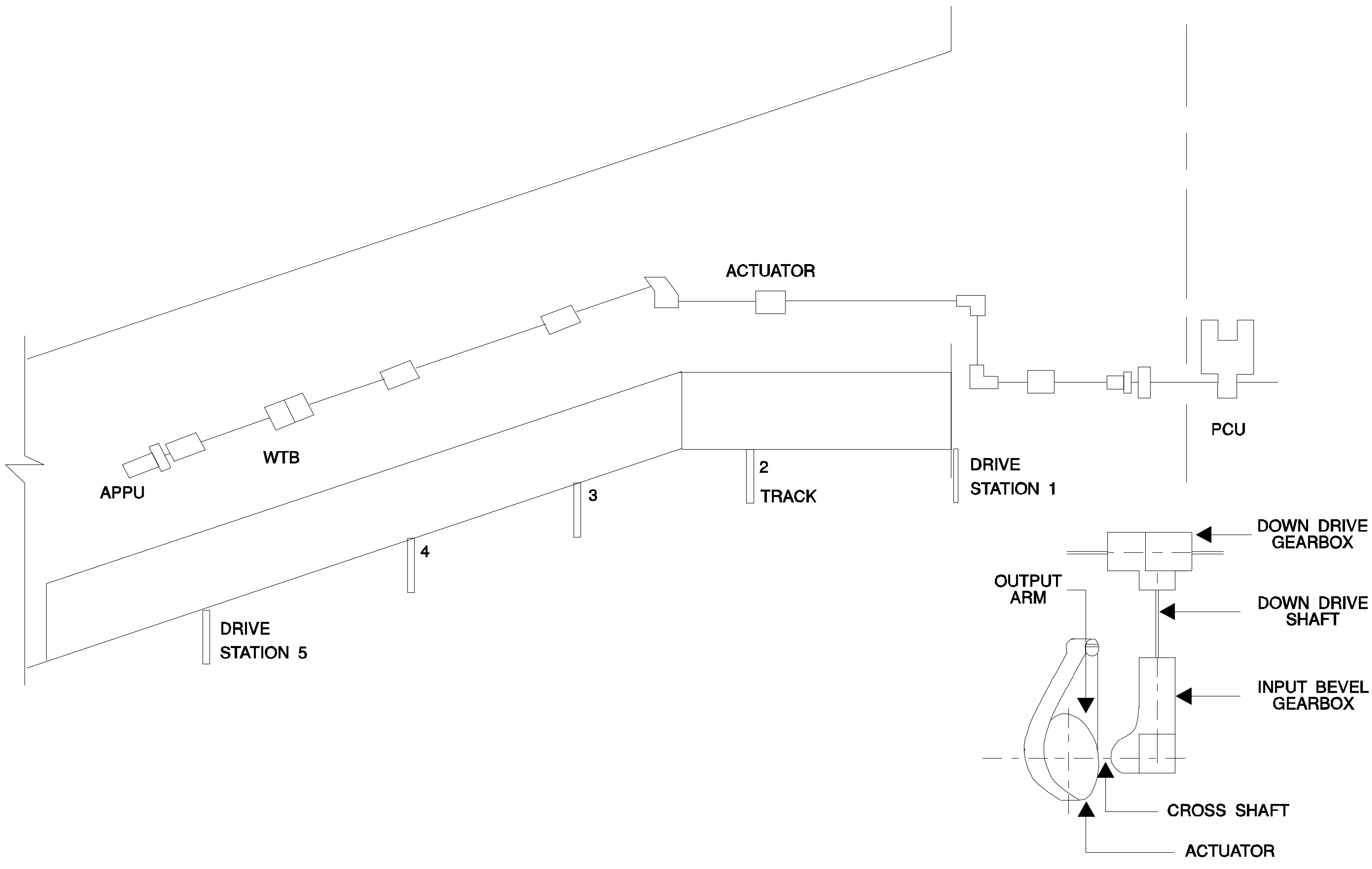
GENERAL

At each flap drive station, the down drive gearbox transmits the mechanical power through the down drive shaft, the input bevel gearbox and the cross shaft to the actuator.

Each flap is supported by carriages which run in tracks extending from the wing rear spar.
The drive station gives the necessary torque and decreases the speed to move the flaps at the required speed.



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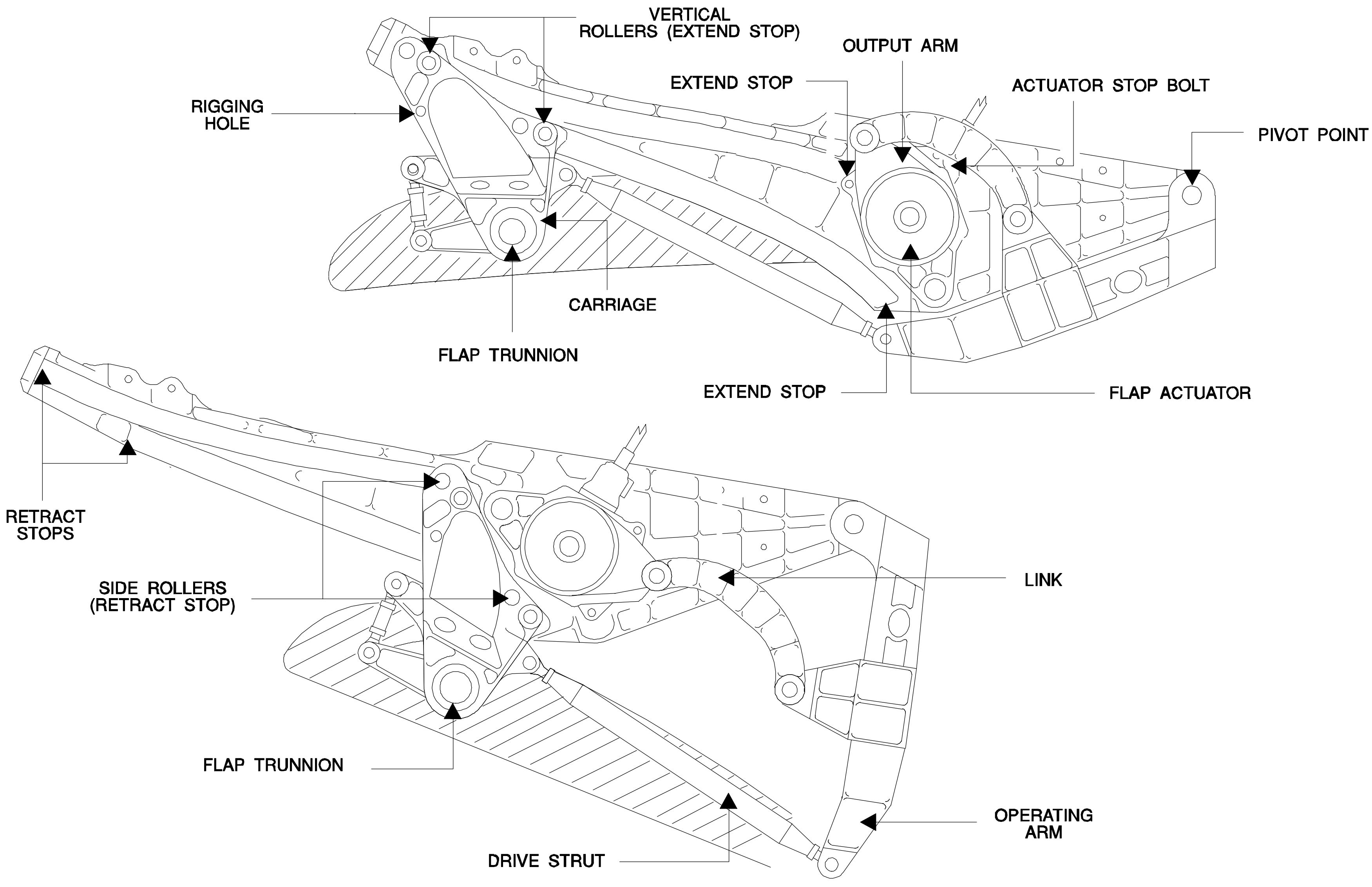
DRIVE STATION 1

The upper part of the carriage is provided with a rigging pin hole.

The rotary actuator is equipped with an output arm attached directly to the flap drive linkage.
The actuator and output arm form an integrated assembly mounted on the flap track beam.

Track 1 is attached to the fuselage.

The link, when moving, drives the strut which simultaneously drives the carriage along the track.



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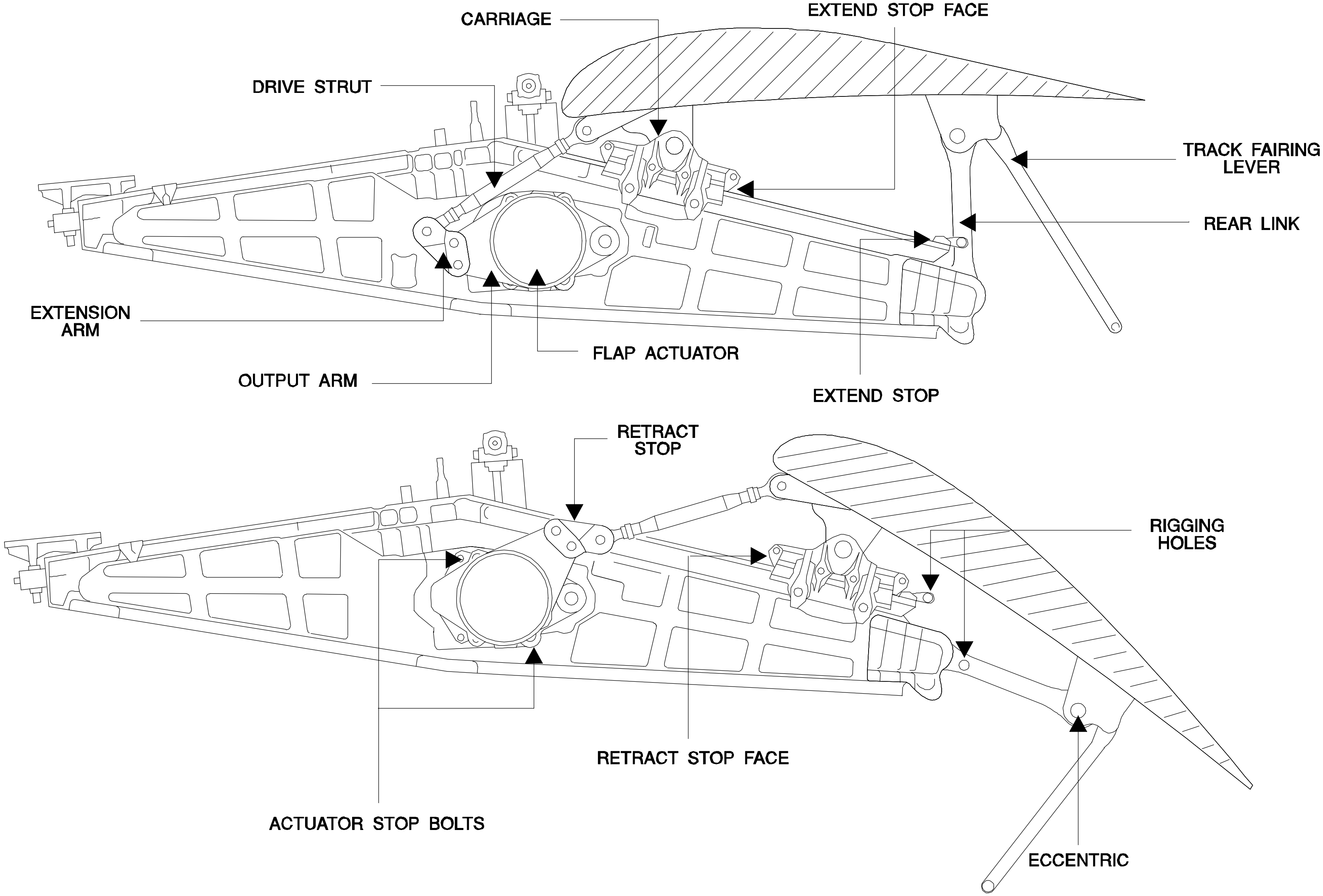
DRIVE STATIONS 2, 3, 5

Drive stations 2, 3 and 5 are identical in design and in operation.

Each carriage is held on its track by vertical and side-load rollers and is attached to the flap by bolts.
The bolts have eccentrics which let you adjust the flap.
The rollers are lubricated through individual grease points.

The output arm of the actuator is connected to an extension arm which guides the drive strut.
The struts, when moving, drive the carriages on which the flaps are attached.

A rear link, equipped with an eccentric, connects the flap to the track. Each rear link has a rigging pin hole used together with the rigging pin holes in the stop plate of the track support when rigging the flaps.



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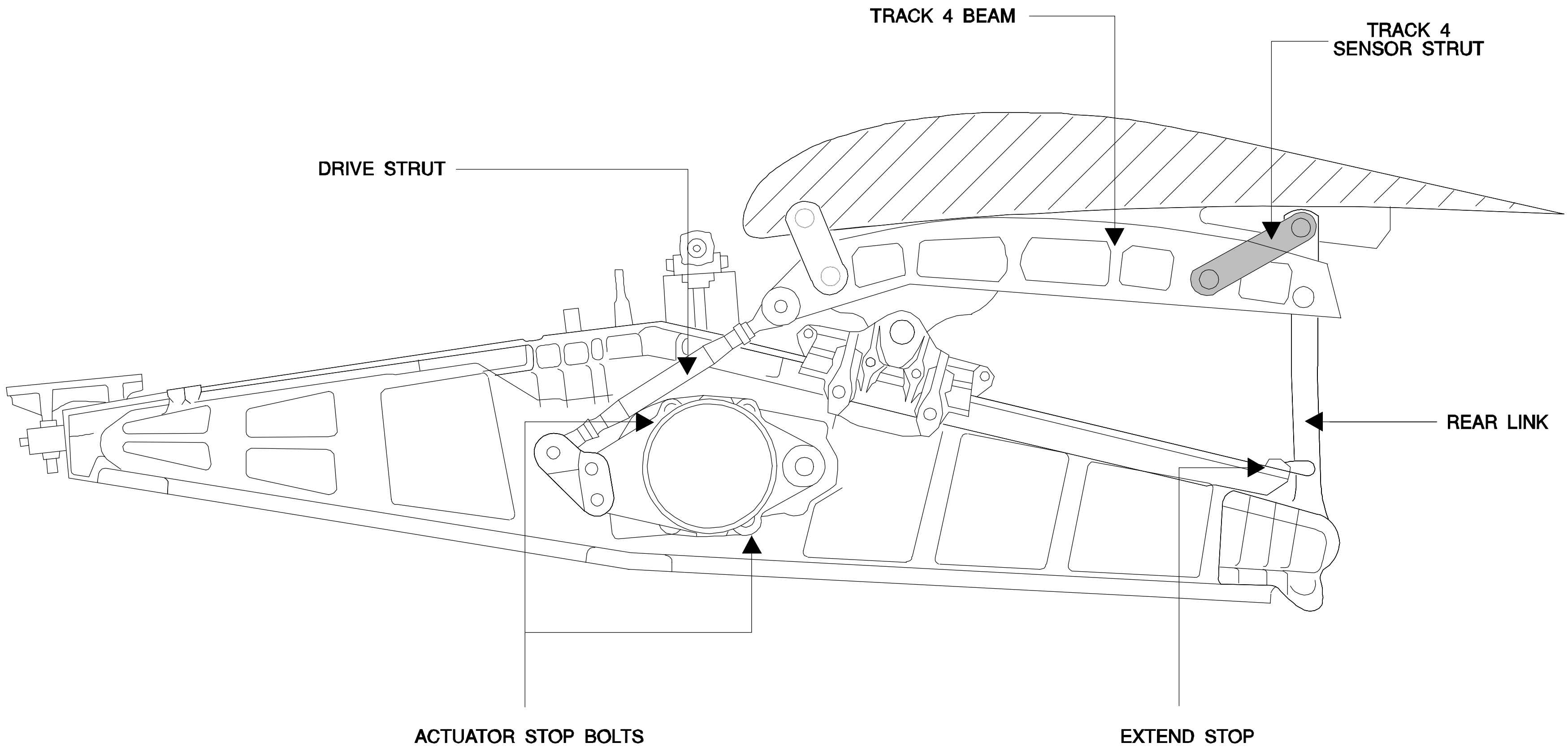
DRIVE STATION 4

Station 4 is similar in operation to drive stations 2, 3 and 5.

The outer flap is driven by three rotary actuators.
The center one operates the flap through an additional track beam which takes up the deformations of the parallelogram formed by the track beam and the flap attachment points.

A sensor strut, equipped with 2 disconnect sensors for flap attachment failure monitoring, is mounted between the beam assembly and the flap.

During flap operation, there is a relative movement between the beam assy and the flap.
Should this movement exceed the normal range, the disconnect sensors send discrete signals to the SFCCs in order to stop flap operation.



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STUDENT NOTES

SLATS AND FLAPS NORMAL OPERATION

General
Extension

GENERAL

This item deals with the normal operation of the slat/flap system for an extension sequence.

The Power Control Unit (PCU) valve block includes four solenoid valves S1, S2, S3 and S4.

Two directional valves command the control valve spool for extension (S1) or retraction (S2).

The high speed solenoid valve (S3) controls the high speed mode of the motor and the brake solenoid valve (S4) controls the Pressure Off Brake.

EXTENSION

The surfaces are fully retracted and the Power Control Unit is in standby mode.

The position demand from the control lever and the actual position data provided by the Feedback Position Pick-Off Unit (PPU) are compared.

As the demanded position and the actual position data are different, each slat lane generates a command signal.

The signals generated by each lane are compared to check whether they are identical or not.

As both lanes agree (identical signals), an extend drive command is sent by each Slat Flap Control Computer (SFCC) to activate its associated PCU valve block.

As the extend solenoid valve is energized, the control valve spool moves from the neutral position.

The movement of the control valve spool connects the hydraulic system to the pressure switch, to the brake solenoid valve and to the hydraulic motor.

The brake solenoid valve is energized, thus releasing the Pressure Off Brake.

The motor starts running in the low speed mode and the slats begin to extend.

At a given motor speed, SFCC1 energizes the high speed solenoid valve and the spool moves further from the neutral position.

The flow of hydraulic fluid to the motor increases and the motor runs at high speed.

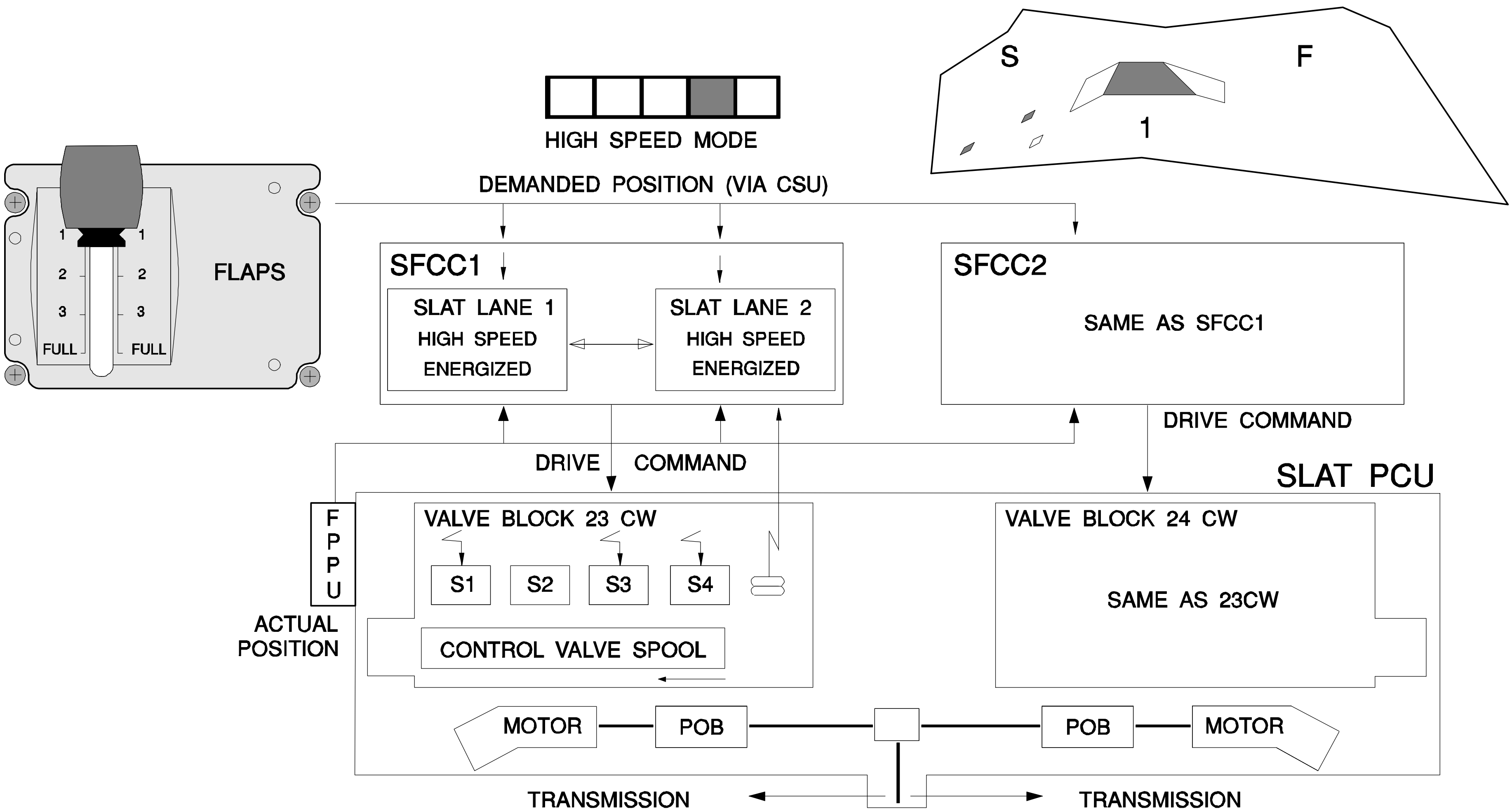
As the slats approach the demanded position, the high speed valve is de-energized.

The control valve spool moves back towards the neutral position and the motor returns to the low speed mode.

When the selected position is reached, the brake solenoid valve is de-energized.

As the brake solenoid valve is de-energized, the motor and the input shaft shaft of the differential gearbox are stopped.

Shortly after the directional valve is de-energized and the spring moves the control valve back to the neutral position.
The system remains in the standby mode till a successive drive command is sent.



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STUDENT NOTES:

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POWER CONTROL UNIT (PCU) DESCRIPTION AND OPERATION

General
Extension

GENERAL

PCU STANDBY MODE

Here is the hydraulic actuation of the slats; flap operation being identical.

Valve block 23CW and related motor are actuated by the green system and controlled by SFCC1, valve block 24CW and related motor are actuated by the blue hydraulic system and controlled by SFCC2.

Note : Valve block 23CW is shown only.

EXTENSION

PCU START UP SEQUENCE

EXTEND ENERGIZED

The extend solenoid valve is energized and the main control valve spool moves from the neutral position.

Hydraulic fluid is directed to the extend side of the motor (thus creating a torque on the motor output shaft), to the pressure switch and to the brake solenoid valve.

BRAKE SOLENOID ENERGIZED

The pressure switch monitors the pressure of the hydraulic fluid and sends electrical signals to its related SFCC so that the correct operation of the valve is checked.

As SFCC1 energizes the brake solenoid valve, the POB releases and the motor rotates the PCU output differential gearbox which transmits the movement to the slats in the low speed mode, due to the control valve built-in restrictors.

HIGH SPEED SOLENOID ENERGIZED

At a predetermined motor speed, SFCC1 energizes the high speed solenoid valve.
The pressure maintaining valve opens, the valve spool moves further and reaches its stroke limiting stop.

The flow of hydraulic fluid to the motor increases and the motor operates in the high speed mode.
If pressure drops below 140 bar, the PPMV closes and the main control valve spool returns to low speed operation.

PCU SHUT-DOWN SEQUENCE

HIGH SPEED DE-ENERGIZED

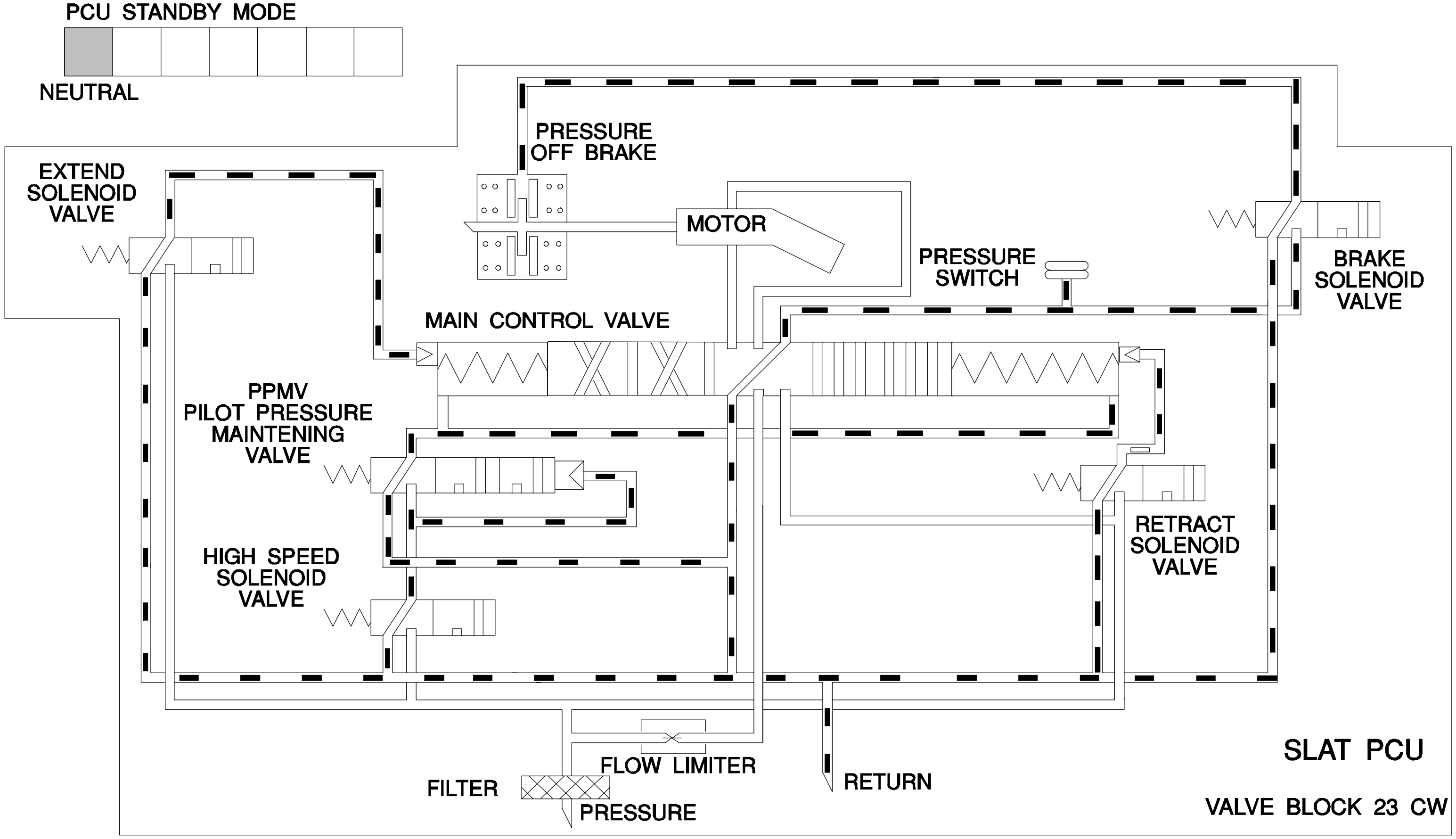
As slats approach the selected position, SFCC1 de-energizes the high speed solenoid valve.

The control valve spool moves back towards the neutral position, the flow of hydraulic fluid to the motor decreases, the motor returns to the low speed mode and the slats operate at a lower speed.

BRAKE SOLENOID DE ENERGIZED

When the slats reach the specified position, the brake solenoid is de-energized.

The POB is applied in order to stop the motor, the input shaft of the differential gearbox and consequently the slats.



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EXTEND DE ENERGIZED

Shortly after, the extend solenoid valve is de-energized.

The spring moves the control valve spool back to the neutral position and the fluid flow to the motor stops.
Then the pressure switch is no longer triggered.

PCU STANDBY MODE

The system remains in the standby or neutral mode until SFCC1 energizes the valve block again.

Note that for a retraction sequence, operation is the same, the retract solenoid valve being energized first.

STUDENT NOTES:

STUDENT NOTES

WING TIP BRAKE OPERATION

GENERAL

The Wing Tip Brakes (WTB) stop and hold the transmission system when certain types of failure are detected.

The WTBs are electrically switched off, hydraulic pressure off brakes.

- Pressure ON : Brake released
- Pressure OFF : Brake applied.

DESCRIPTION

Each Wing Tip Brake is equipped with two solenoid valves, each supplied by one hydraulic system and controlled by one Slat Flap Control Computer (SFCC).

In normal flight conditions, the solenoid valves are permanently energized.

One proximity switch is attached to each Wing Tip Brake and provides a feedback of the brake engagement.

The proximity switches are used for the WTB engagement test, on ground only.
This test is initiated from the MCDU, to check the correct operation of the WTB.
Data is transmitted from one channel to the other via an ARINC bus.

WING TIP BRAKES RELEASED

The Wing Tip Brakes are released when hydraulic power and electrical power are applied to the aircraft.

Note that with one solenoid valve de-energized or one hydraulic system faulty, the second hydraulic circuit is still able to keep the brake released.

WING TIP BRAKES APPLIED

If either lane of one SFCC detects a failure, its own Wing Tip Brake solenoids are de-energized and a FAULT signal is sent to the second SFCC channel.

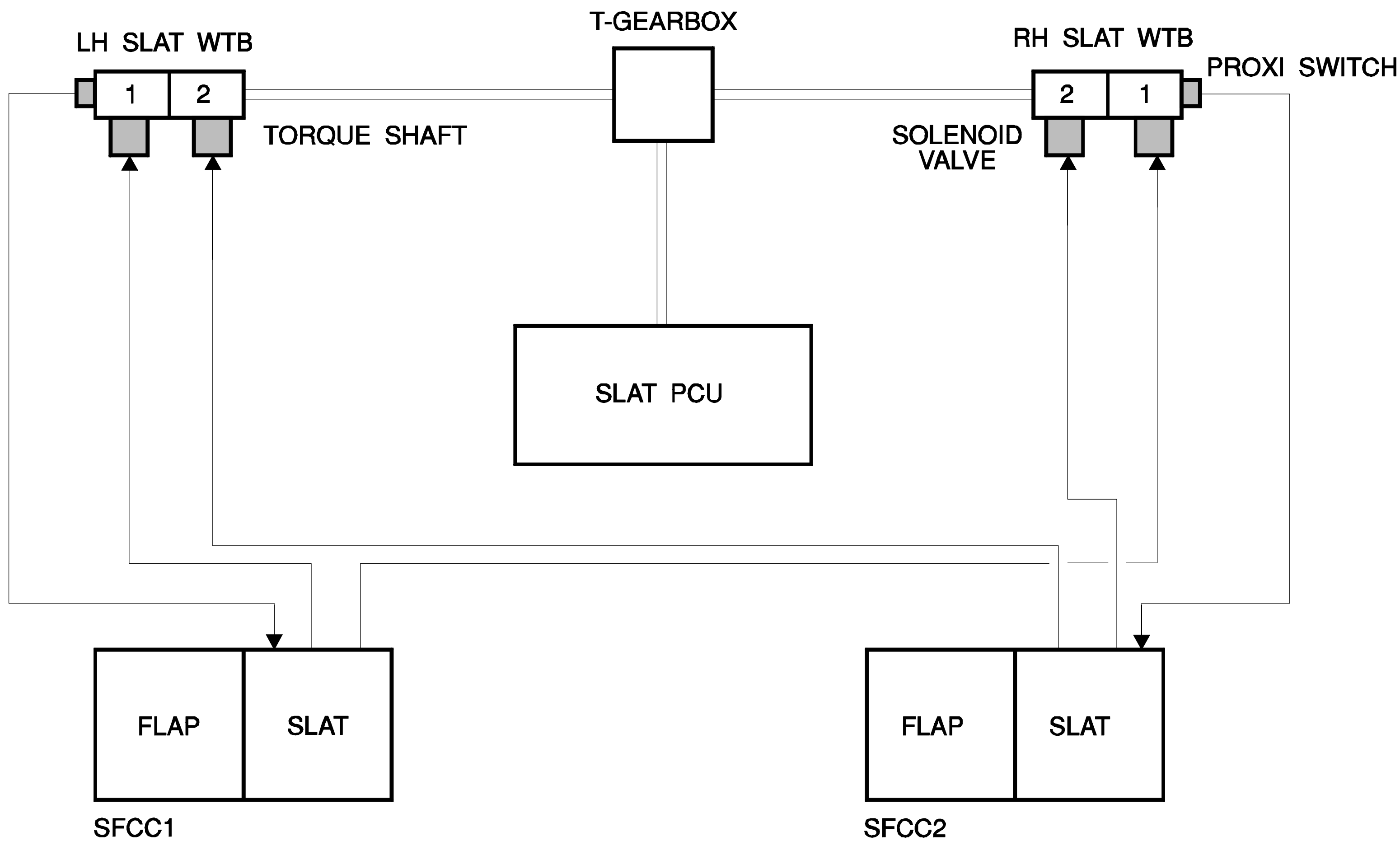
At this point, the Wing Tip Brakes are still released.

If the failure is confirmed by the second SFCC, its associated solenoid valves are de-energized.

The circuits are de-pressurized and the Wing Tip Brakes are applied.

RESET

When applied, the Wing Tip Brakes are reset on ground via the MCDU and the CMC.



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STUDENT NOTES:

SLATS AND FLAPS ABNORMAL OPERATION (LOCKING)

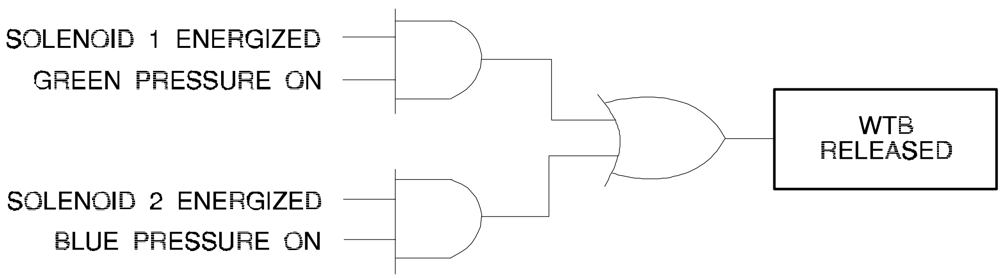
GENERAL

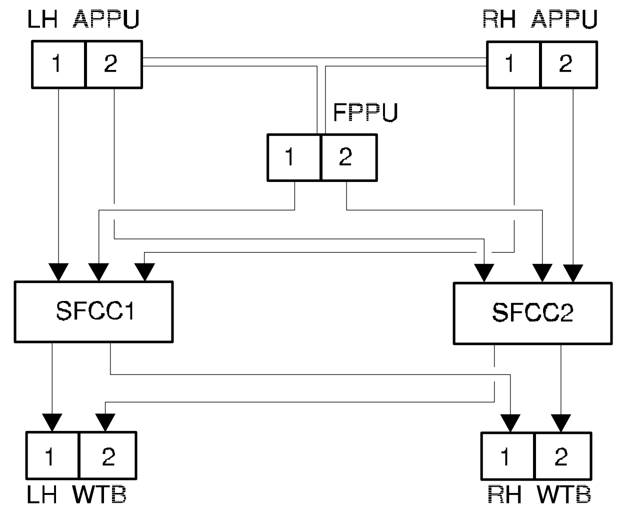
Here is a brief reminder of the wing tip brake application logic. Asymmetry, Runaway, Overspeed and Uncommanded Movement are detected by cross comparison of Asymmetry Position Pick-off Unit (APPU) and Feedback Position Pick-off Unit (FPPU) signals.

If any of these failures are detected by one Slat Flap Control Computer (SFCC) and confirmed by the second one, the wing tip brakes are applied.

Note that if one SFCC doesn't operate, the connected Wing Tip Brake (WTB) solenoid is not energized.
Thus, if the second SFCC subsequently detects a failure, the related solenoid will be de-energized and the WTBs applied.

WING TIP BRAKE LOGIC





APPU	ASYMMETRY POSITION PICK OFF-UNIT
FPPU	FEEDBACK POSITION PICK OFF-UNIT

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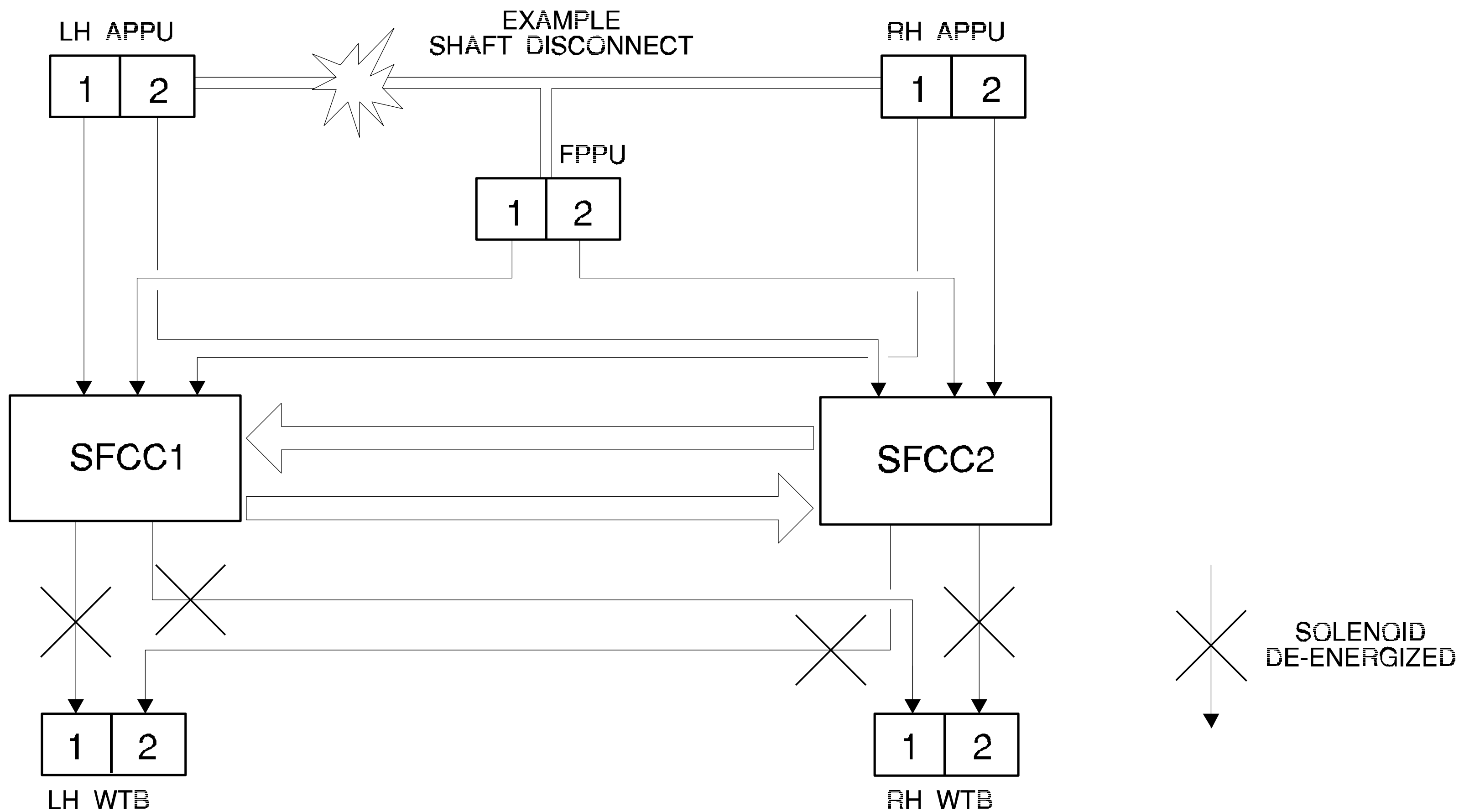
ASYMMETRY

Asymmetry is defined as a positional difference between the LH and RH Asymmetry PPUs.

Asymmetry is usually due to a broken shaft (other than common PCU output shaft) between both APPUs.
The Asymmetry threshold is above 5.625° synchro positional difference between both APPUs.



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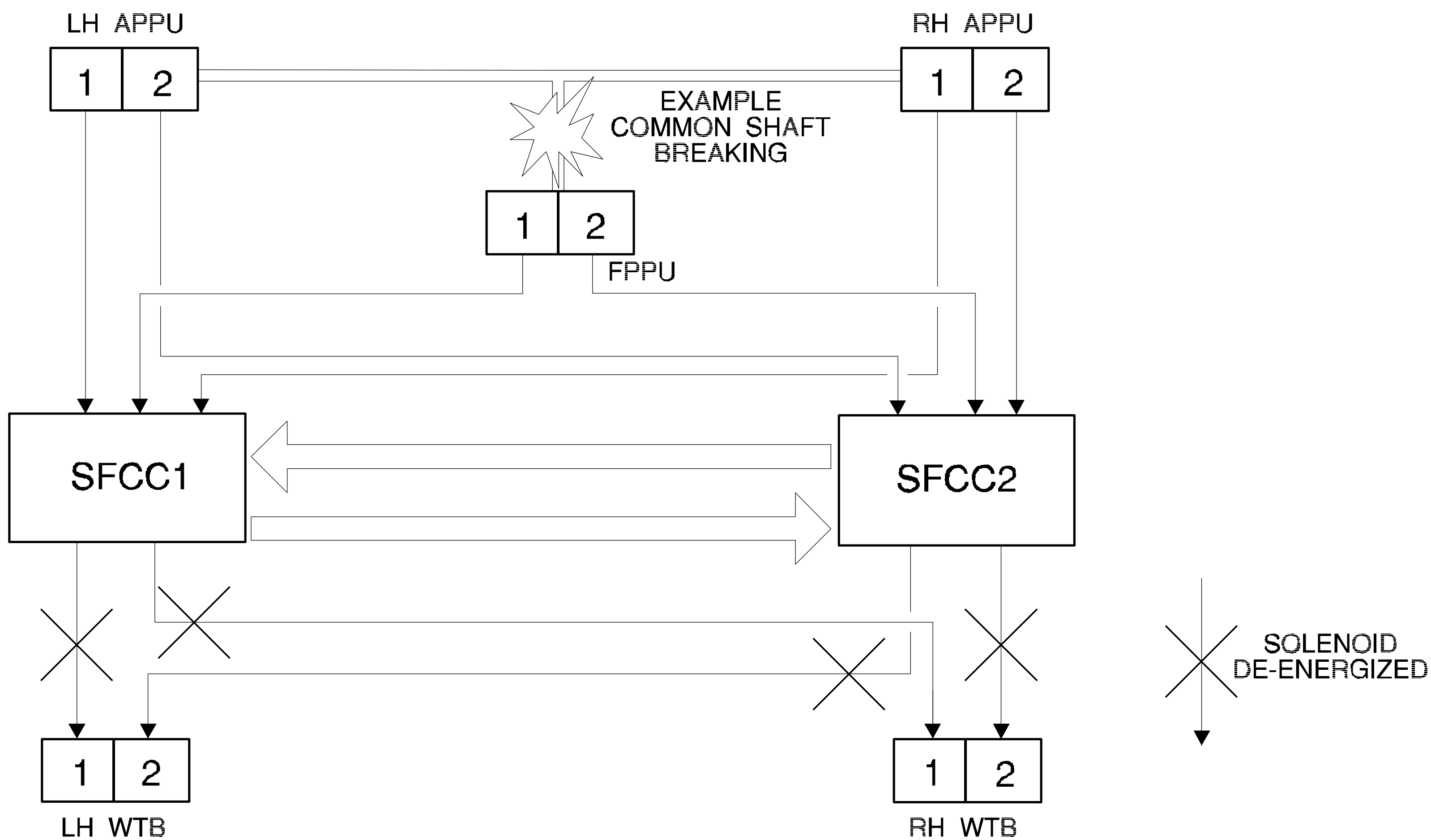
RUNAWAY

A Runaway is given as a positional difference between both Asymmetry PPUs and the Feedback PPU.

Runaway can occur when a component of the torque shaft drive, common to the LH and RH wings breaks, leaving the slat or flap system isolated from the PCU brakes.
This results in airloads tending to retract the surfaces.



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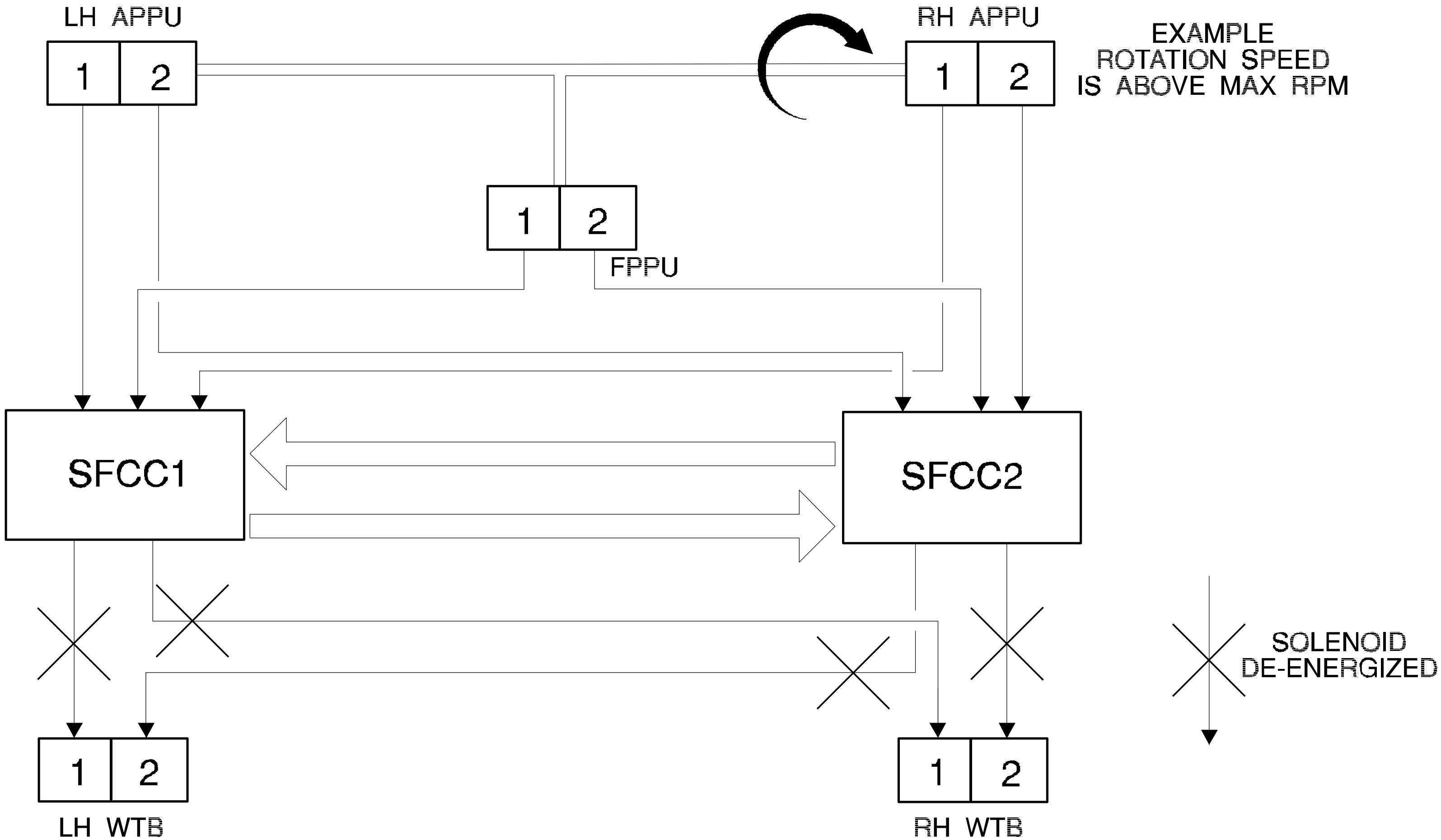
OVERSPEED

An Overspeed is detected when the rotation speed of the torque shafts measured at the APPU is too high.



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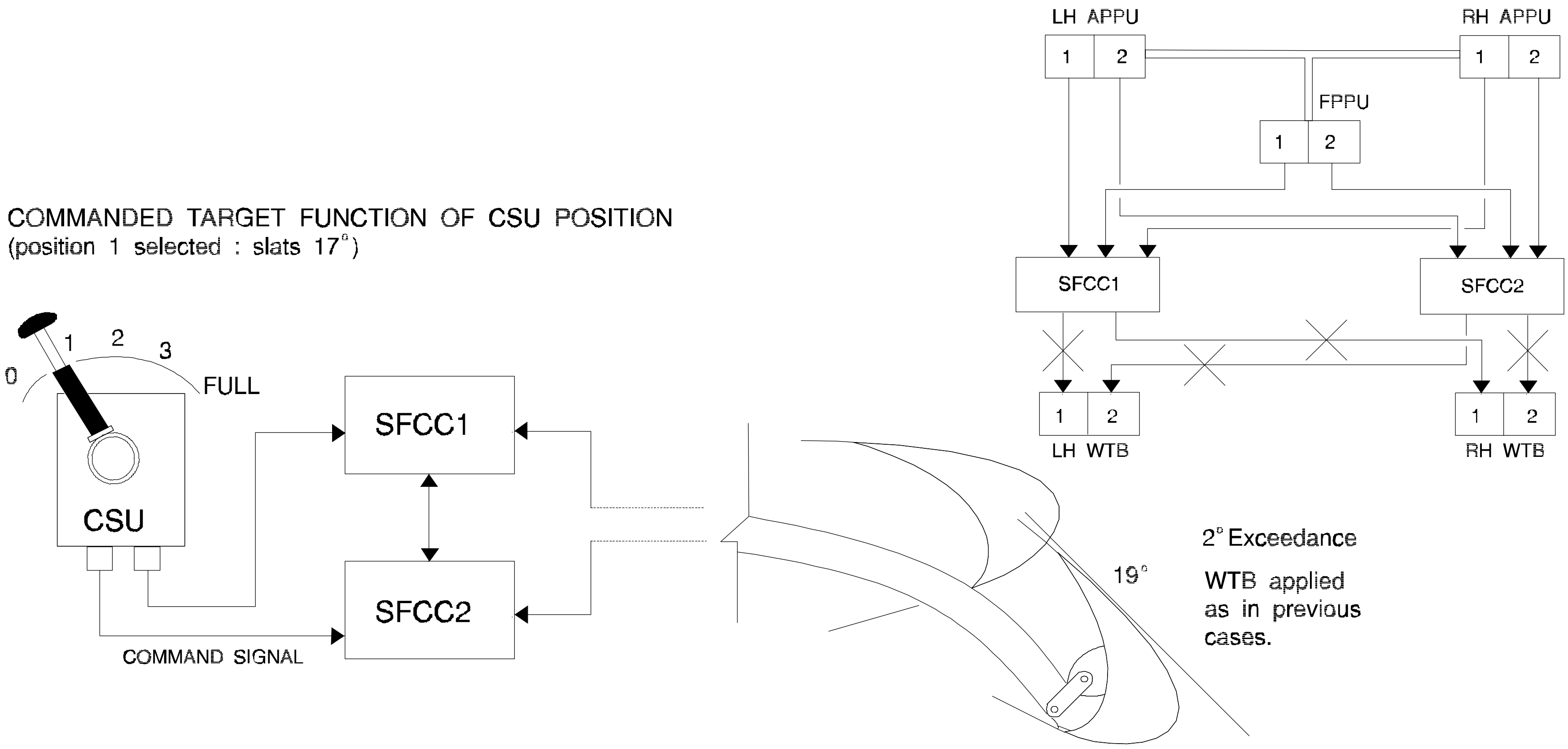
UNCOMMANDED MOVEMENT

Uncommanded Movement is defined as a movement away from the commanded target by a value which exceeds the threshold.

COMMANDED TARGET FUNCTION OF CSU POSITION
(position 1 selected : slats 17°)



FAILURE MONITORING

The Power Control Unit (PCU) is in operation.
The extend solenoid valve S1 and the brake solenoid valve S4 are energized and the flaps begin to extend.

Position Pick-off Unit information is used for system monitoring.

Asymmetry is detected by SFCC1.
An abnormal shut down of the associated valve block is performed and further start up is inhibited.

The related WTB solenoids are de-energized and a FAULT message is sent to SFCC2 flap channel to check whether asymmetry is confirmed or not.

Asymmetry is confirmed by SFCC2 which de-energizes its associated WTB solenoid valves.

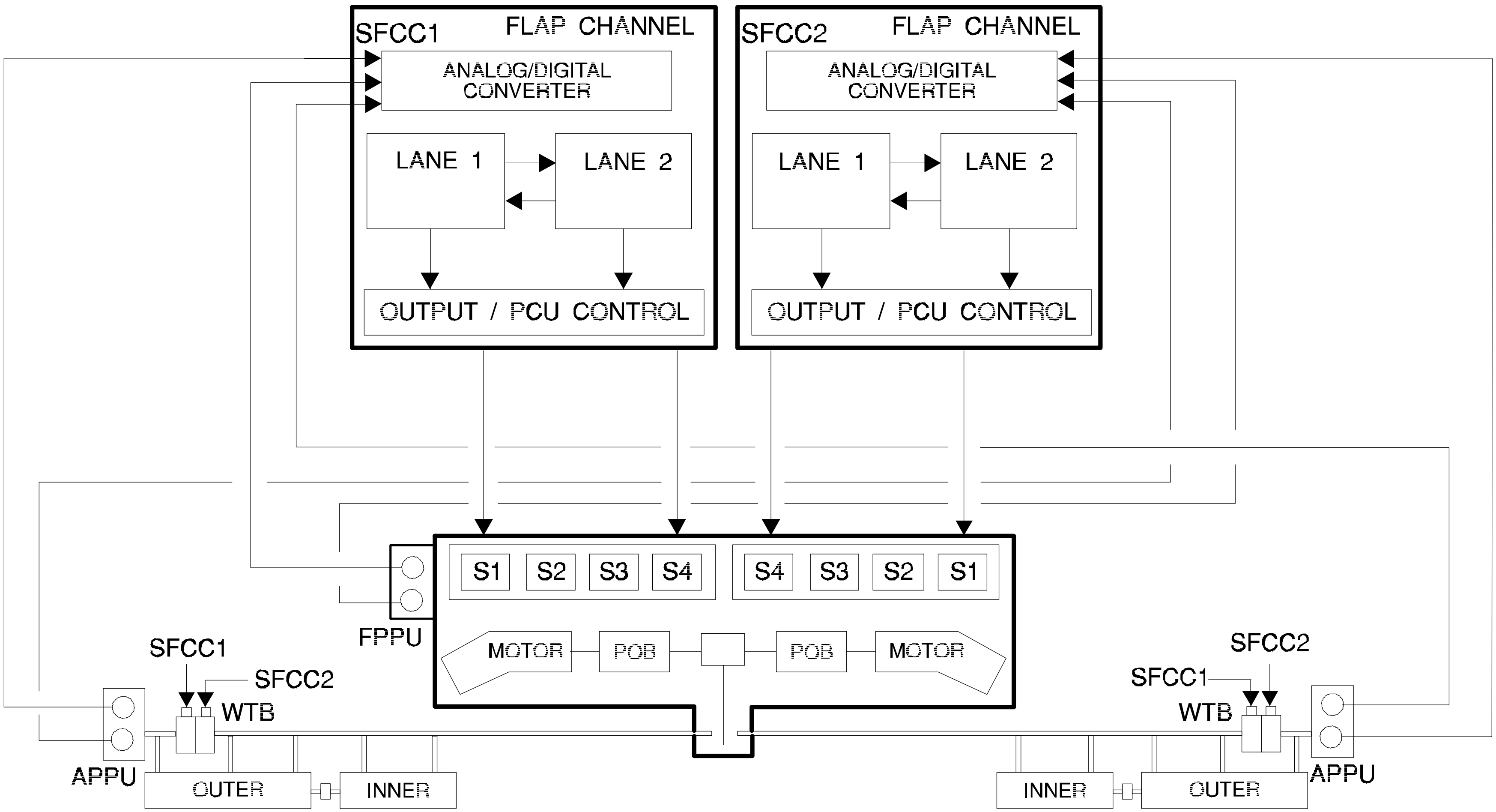
The WTBs are applied and software latched (reset on ground only via the CMS).
The valve block start up inhibition is confirmed.

In the case where asymmetry is not confirmed by the second computer, this is interpreted as a PPU FAULT.

A PPU FAULT is assumed by the SFCCs and the yellow valve block and the WTB solenoids related to SFCC2 are not de-energized.

If the unconfirmed asymmetry disappears from the first channel and the flight crew selects a new CSU position, the following actions are performed :

SFCC1 energizes its associated WTB solenoids, it cancels the start up inhibition from its related PCU valve block and the FAULT message to the other SFCC.



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STUDENT NOTES:

SLATS AND FLAPS ABNORMAL OPERATION (HALF SPEED)

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GENERAL

Half speed operation is assumed when a Line Replaceable Unit (LRU) single failure occurs, leading to an abormal shut down of the related Power Control Unit (PCU) valve block.

With one PCU motor inoperative, the transmission system moves at half of the normal operation speed.

POSITION PICK-OFF UNIT (PPU) SYNCHRO FAULT

Let's study an example:

- The extend solenoid valve S1 and the brake solenoid valve S4 are energized and the flaps start to move in the low speed mode.

Synchro data is used for system monitoring and synchro monitoring is active as long as the Slat Flap Control Computers (SFCCs) are powered.

Because of an electrical breakdown in the wiring of one Feedback PPU synchro, SFCC2 flap channel considers a runaway condition.

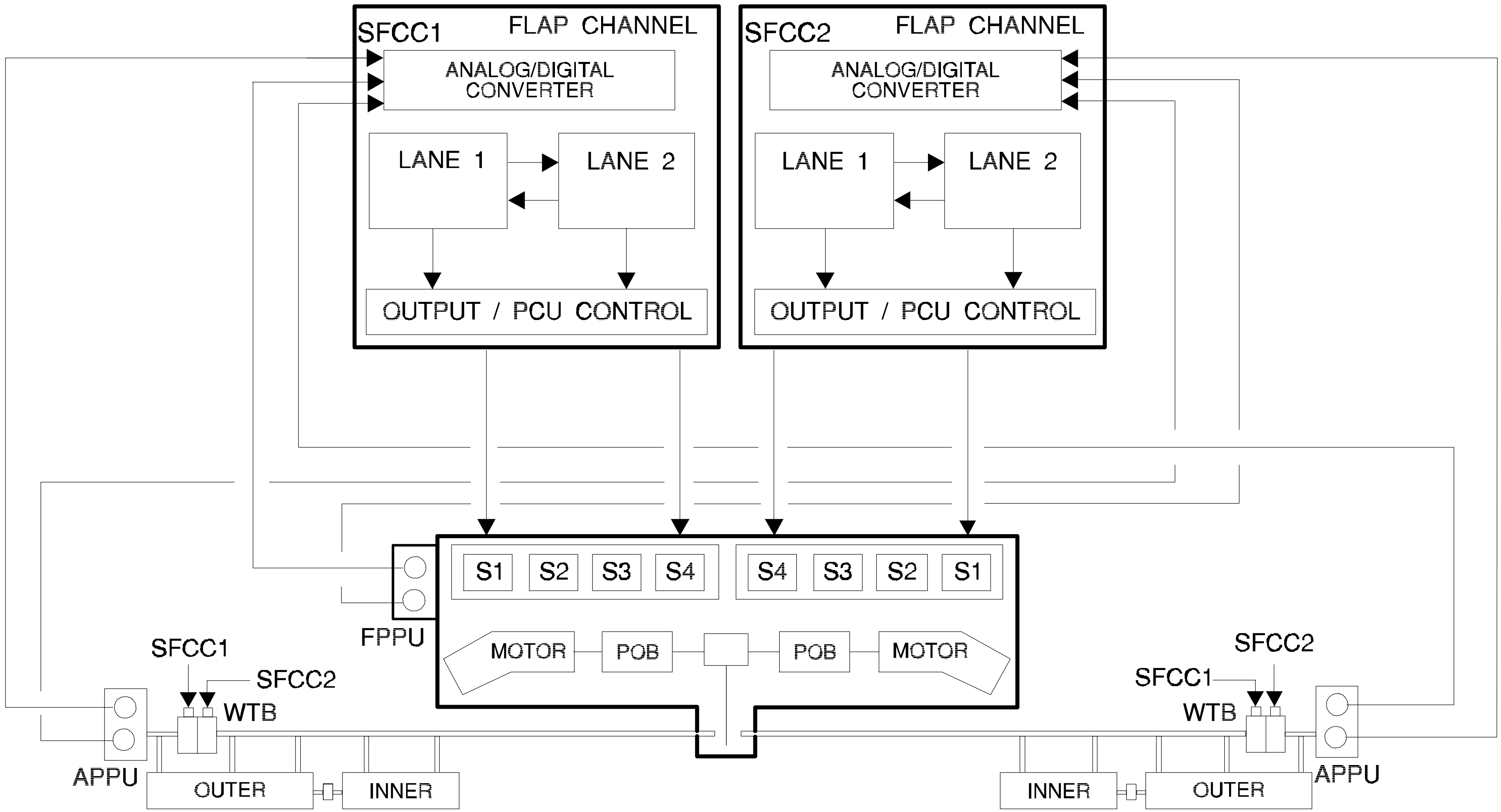
An abnormal shut down of the associated PCU valve block is performed and further start up is inhibited.
The related Wing Tip Brake (WTB) solenoids are de-energized and a FAULT message is sent to the other channel.

SFCC1 flap channel doesn't confirm the runaway condition through the ARINC 429 cross computer data link.
As runaway is not confirmed, SFCC2 interpretes this as a failure in one PPU synchro and the fault message is stored in a non volatile memory.

The start up inhibition of the "yellow" valve block is maintained and the flap system operates at half speed.

The related Wing Tip Brake solenoids remain de-energized.

The Wing Tip Brakes can then be applied in case of a further asymmetry or detection of any failure requiring their application.



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FAILURE TABLE

Here is the table summarizing the failures that lead to half speed operation.

MONITORED FAILURE	ECAM MESSAGE		MOTOR STATUS	SYSTEM STATUS
	E/W DU	SYS/STATUS CRT		
- FLAP CHANNEL FAILURE - CSU FAILURE (INVALID PATTERN) - PPU SYNCHRO - PRESSURE SWITCH - VALVE BLOCK SOLENOID - LOW HYDRAULIC PRESSURE - OPERATION MODE CODING - SFCC DC SUPPLY - SYNCHRO EXCITATION SUPPLY	FLT CTL FLAPS SYS 1(2) FAULT	FLAPS SLOW	STOPPED	HALF SPEED
- HYDRAULIC MOTOR JAM		FLAPS SLOW	STOPPED	HALF SPEED

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STUDENT NOTES:

FLAP ATTACHMENT FAILURE DETECTION SYSTEM

PRINCIPLE

Two separate flap attachment failure detection systems are installed on each wing.

A flap interconnecting strut between the inner and outer flap is equipped with two disconnect sensors which monitor the relative displacement of the two flap panels in case of a broken bolt in drive stations 1, 2 or 3.

A beam assembly is installed on each flap track 4.

A track 4 sensor strut mounted between the beam assembly and the outer flap is equipped with two sensors which monitor the connected flaps in case of a disconnect in drive stations 4 or 5.

DETECTION

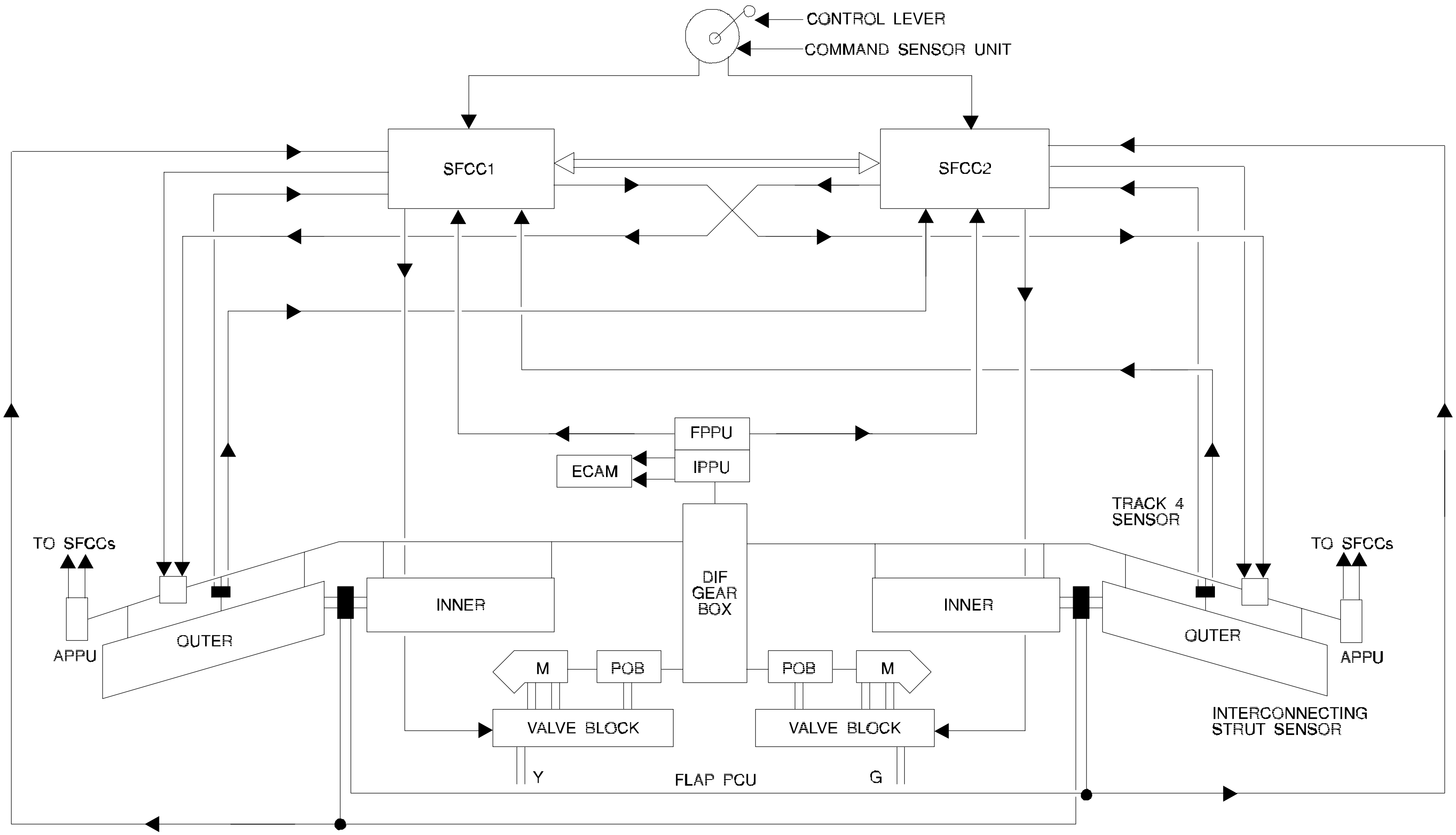
Each flap interconnecting strut sensor and each track 4 sensor is connected to its related SFCC.

In both cases, (flap interconnecting strut and flap track 4), if the target moves out of the normal limits, the proximity sensors send a "target far" signal to their related SFCCs.

As soon as a SFCC detects a flap disconnect, the following actions are carried out :
- an abnormal shutdown of the corresponding valve block is performed and further start up is inhibited.
- a fault message is transmitted to the flight crew, and a failure message is sent to the other SFCC through the ARINC 429 cross computer data link.

If the second SFCC confirms the failure, the start up inhibition is confirmed and the fault message is held in the non volatile memory.

The flaps are locked by the PCU Pressure Off Brakes and flap operation is inhibited for the remainder of the flight.
Reset is possible on ground or after power up.



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INTERCONNECTING STRUT

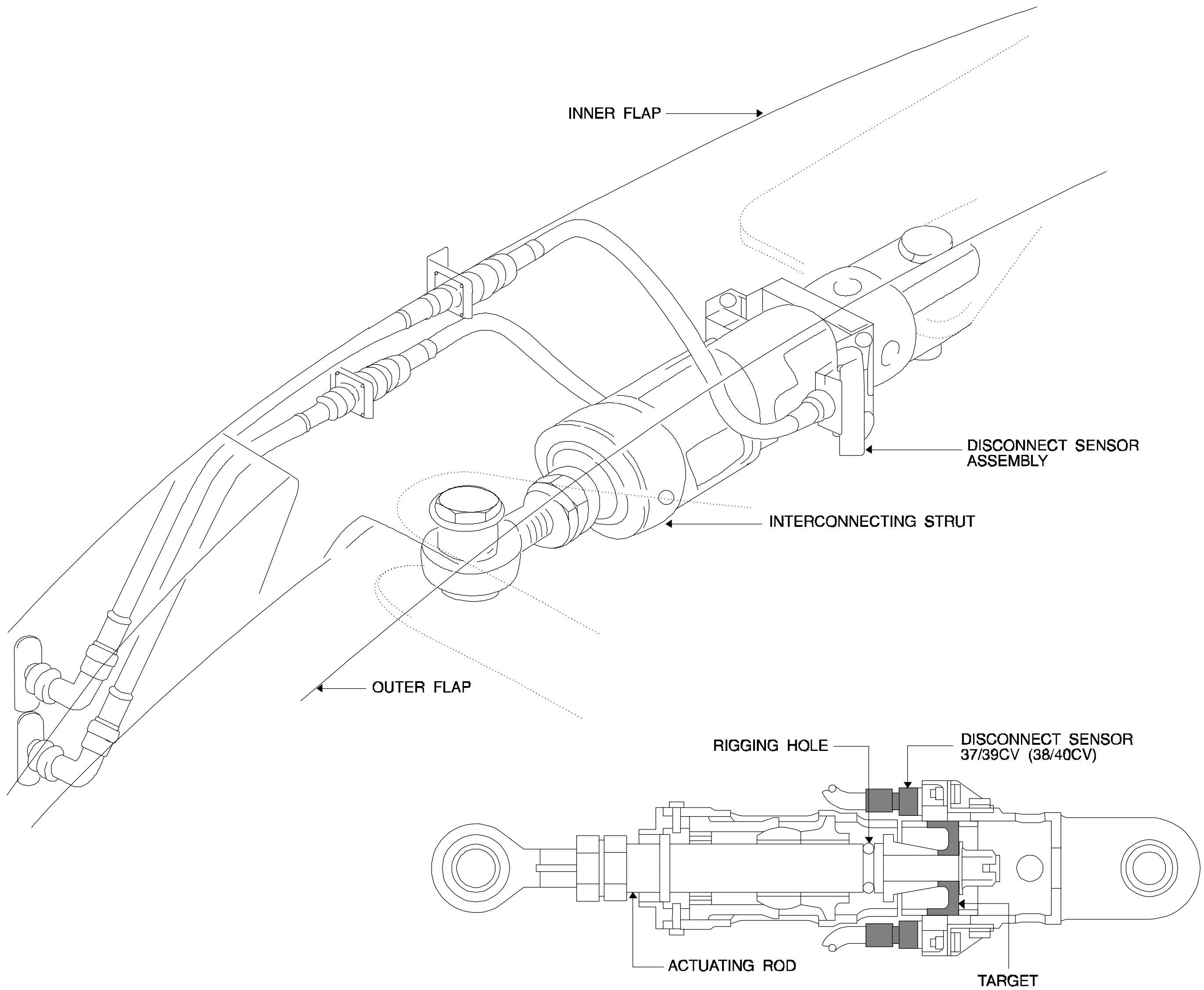
The differential movement between the inner and outer flap is taken up by the interconnecting strut.

In the event of a disconnect(attach breakdown) in drive stations 1, 2 or 3, the disconnect sensors send data to the SFCCs, to indicate that the limit of differential movement has been exceeded.
In that case, the interconnecting strut gives an alternative load path for the flap drive.

The flap interconnecting strut has :

- a housing
- an actuating rod
- a target
- a ball piece
- a sleeve.

The target is at the end of the actuating rod.
The two sensors are on the housing to agree with the normal position of the target.



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TRACK 4 SENSOR STRUT

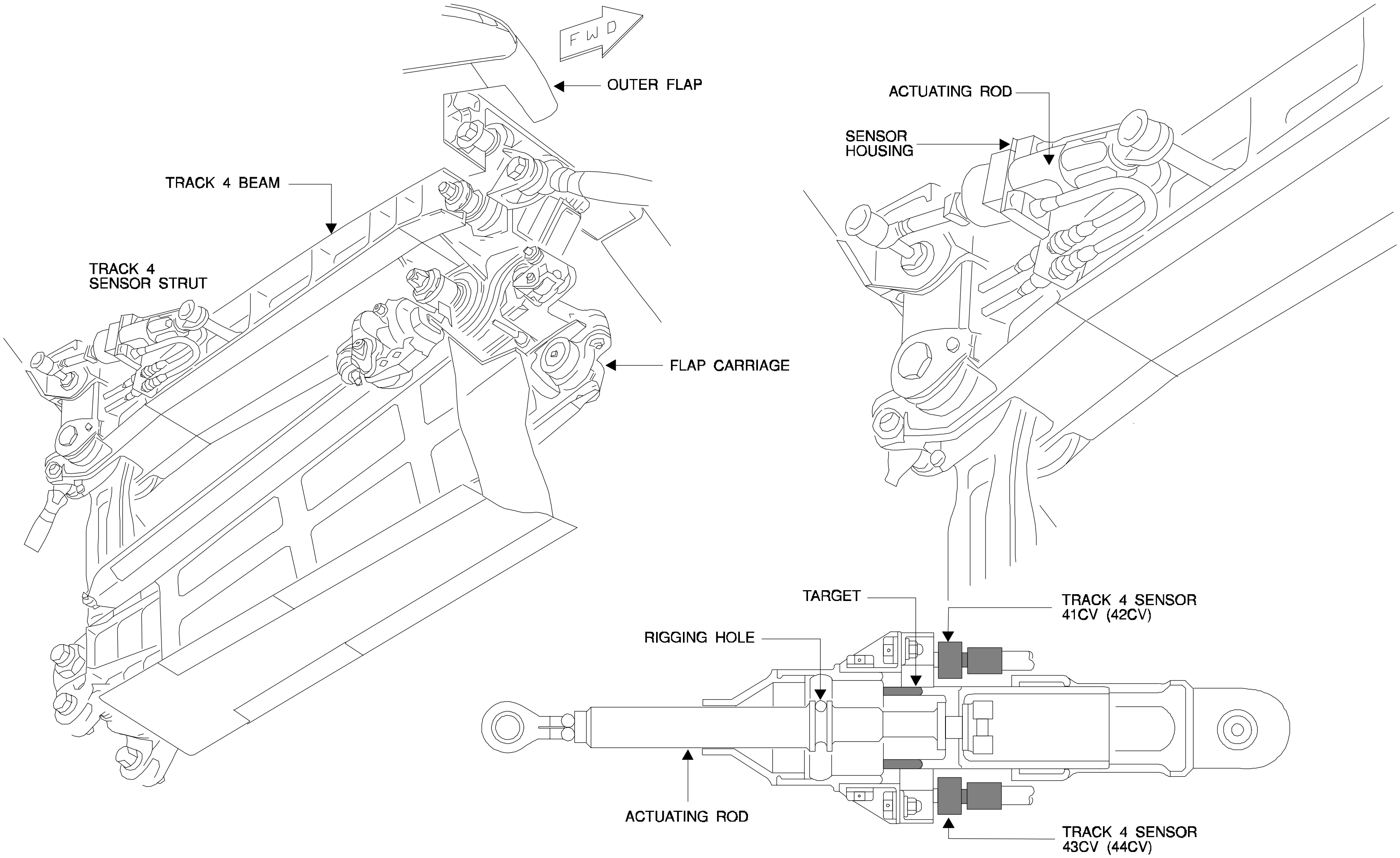
The track 4 sensor strut provides information about the relative position of the outer flap to the SFCCs.

Flap track 4 fault is defined as the exceeding of the normal relative movement between the track 4 beam assembly and the flap.

If the drive at station 4 or 5 becomes disconnected, the beam assembly is displaced relative to the flap.

This causes a relative movement in the extend or compression direction between the actuating rod and the sensor housing.

If the target moves out of the normal limits, the sensors send a target far signal to their related SFCCs.



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STUDENT NOTES:

SLAT FLAP CONTROL COMPONENTS

Control Lever
Command Sensor Unit (CSU)
Slat Flat Control Computer (SFCC)

SAFETY PRECAUTIONS

WARNING : PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :

- THE FLIGHT CONTROLS,
- THE FLIGHT CONTROL SURFACES,
- THE LANDING GEAR AND ASSOCIATED DOORS.

WARNING : MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING : MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING : MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.

STUDENT NOTES

CONTROL LEVER

FIN : 51CV

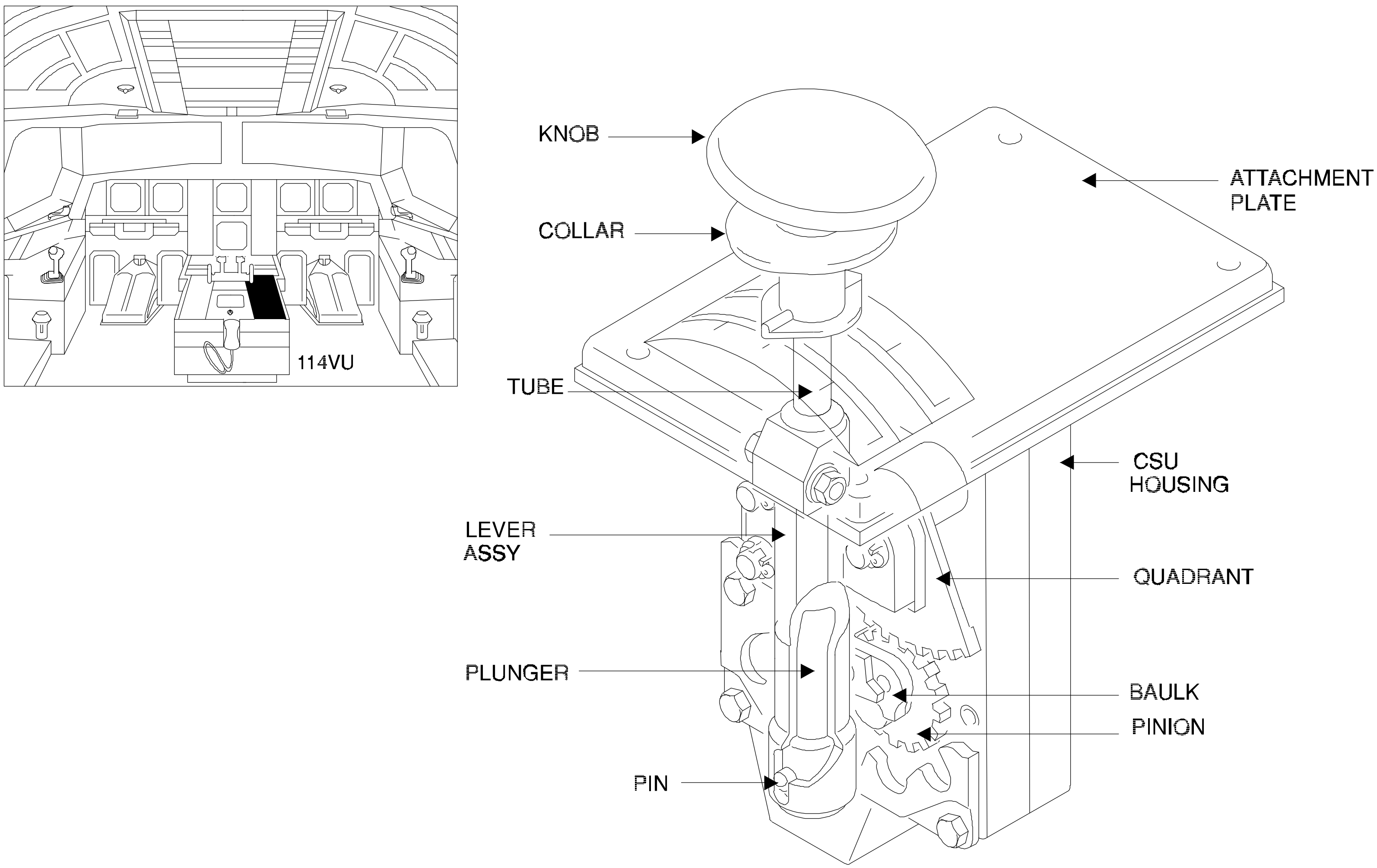
ZONE : 212

COMPONENT DESCRIPTION

The lever assembly with the quadrant and the spring loading plunger has a knob and a collar at one end and a pin at the other end.

SPECIAL DESIGN

To move the lever, lift the collar against the spring pressure.
The pin comes clear of the notch.
To move the lever past the stop, lower the collar again.
This prevents full travel of the lever in one movement.



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COMMAND SENSOR UNIT

FIN : 51CV
ZONE : 212
MMEL : NO GO

COMPONENT DESCRIPTION

The Command Sensor Unit is connected to the control lever through a drive shaft.
The CSU has two code wheels each moving between LEDs and photo transistors.
Light is transmitted to the transistors through openings in the code wheels and converted into electrical signals for the SFCCs(see "Electrical Control").
The signals are related to the control lever position (refer to switch pattern).
For a correct command, each SFCC channel must receive the same detent switch pattern from both code wheels.

ELECTRICAL CONTROL

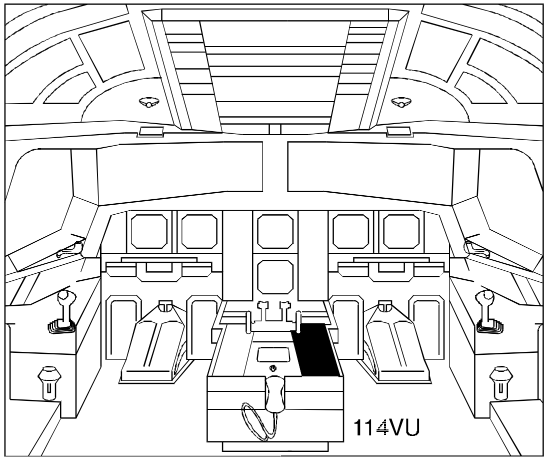
Refer to code wheel schematics.

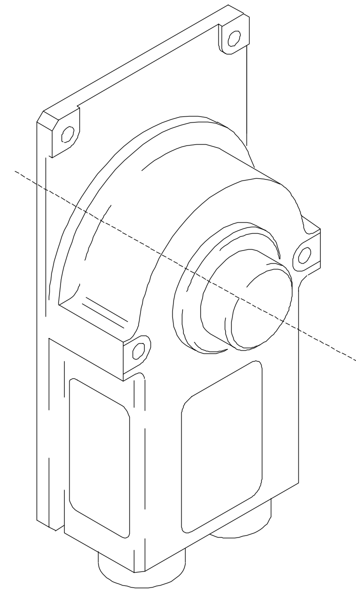
REMOVAL/INSTALLATION

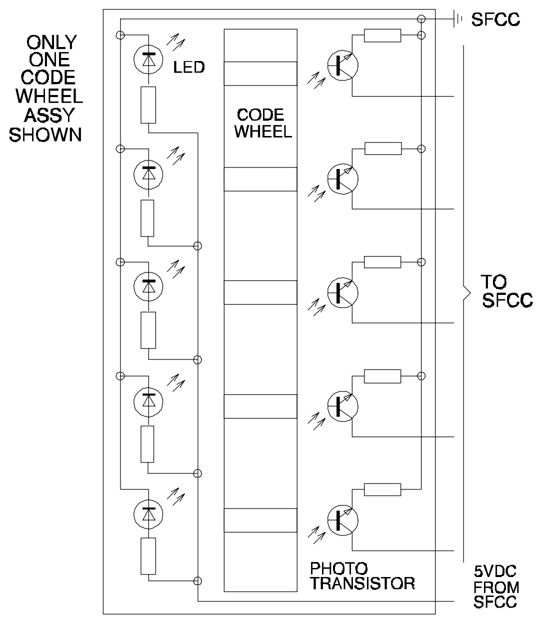
The control lever is connected to a drive shaft which comes out of the CSU body.
Remove the handle lever panel vertically with the CSU and release the drive shaft.

When re-installing the CSU :

- make sure that the lever is set to position 0,
- make sure that the zero mark on the drive shaft is aligned with the fixed zero mark on the housing so that you engage the drive shaft correctly (mechanical zero).







SWITCH PATTERN

LEVER POSITION	0	1	2	3	FULL
TRANS 1	XXXX				XXXX
TRANS 2	XXXXXXXXX				
TRANS 3		XXXXXXXXX			
TRANS 4			XXXXXXXXX		
TRANS 5				XXXXXXXXX	

TRANS 1, 2 .... ⟶ PHOTO TRANSISTORS

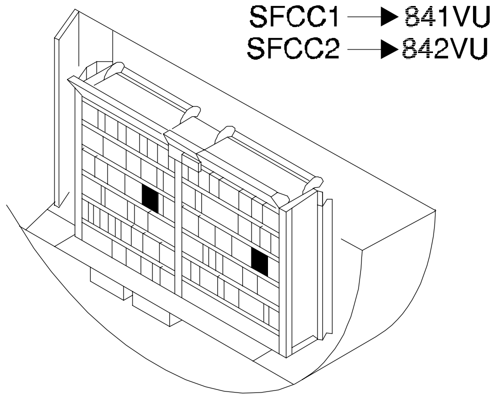
SLAT FLAP CONTROL COMPUTERS

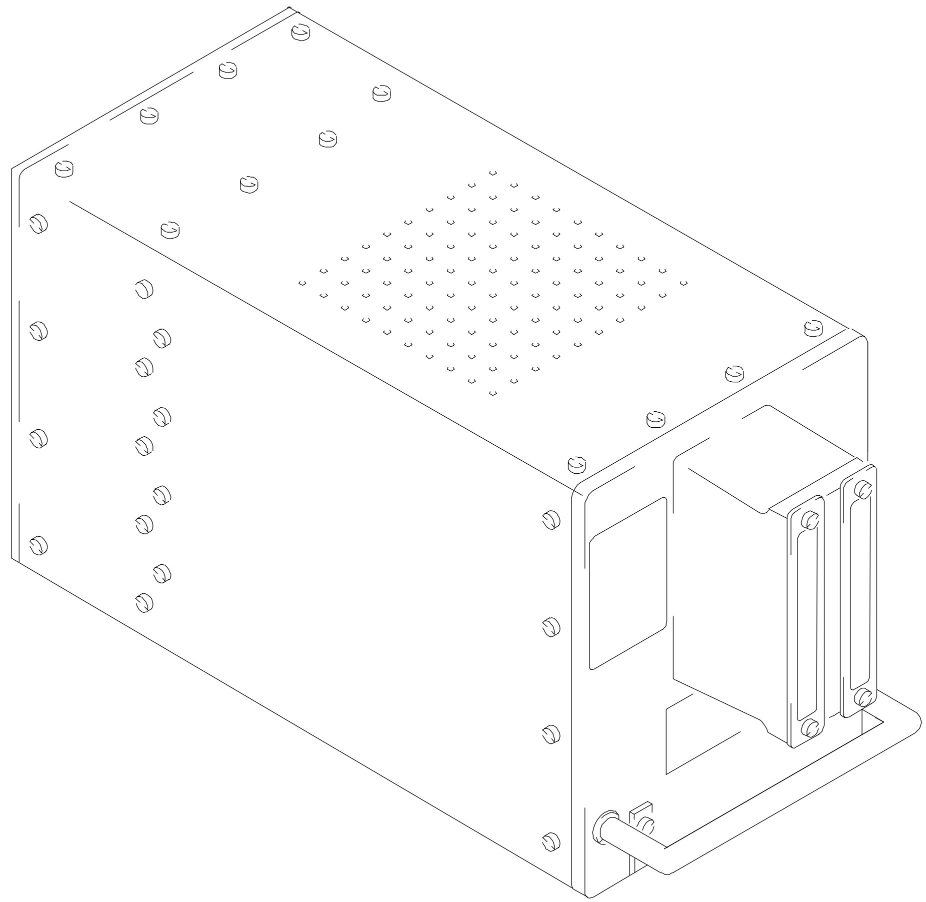
SFCC1 FIN : 21CV
ZONE : 121
MMEL : NO GO

SFCC2 FIN : 22CV
ZONE : 122

COMPONENT DESCRIPTION

Each computer has one slat channel and one flap channel, each including two lanes, (lane A and lane B), having different hardware and software.
Each SFCC has an On Board Replaceable Memory (OBRM) and a Built In Test Equipment (BITE).


SFCC1 ▶ 841VU
SFCC2 ▶ 842VU



STUDENT NOTES

SLAT POWER CONTROL UNIT COMPONENTS

Power Control Unit
Valve Blocks
Hydraulic Motors
Pressure Off Brakes
Position Pick off Units (IPPU and FPPU)

POWER CONTROL UNIT

The slat Power Control Unit allows hydraulic actuation of the slat transmission system.
The following LRUs are attached to the PCU :

- two hydraulic motors
- two valve blocks
- eight solenoid valves
- two pressure switches
- two inlet filters
- one Feedback PPU
- one Instrumentation PPU.

FIN : 5000 CW

ZONE : 143

COMPONENT DESCRIPTION

The PCU casing houses a differential gearbox, including a reduction and differential gear.
There is no final bevel gear assembly and the differential gearbox is directly connected to the transmission system and to the Tee gearbox, to reach the wing leading edge.

REMOVAL INSTALLATION

Apart from the valve block sub units, the bolts for the LRUs are accessible from a single face of the PCU.
Slat and flap PCUs are not interchangeable because the final output shafts and mounting lugs required by the direction of the transmission system are different.

SERVICING

The differential gearbox is lubricated by oil.
Oil filler/level points and drain plugs are installed in accessible positions.

VALVE BLOCK

The total valve block assy is identified as a LRU and is secured to the gearbox casing by a three point attachment.
The two valve blocks are identical in all aspects and component parts are fully interchangeable for both the slat and flap PCUs.
The four solenoid valves of each valve block are the same and interchangeable.
They are not interchangeable with the Wing Tip Brake solenoid valves.
FIN : 23CW/24CW

ZONE : 148

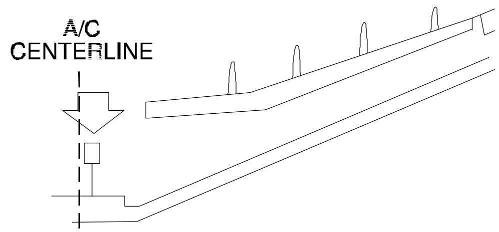
COMPONENT DESCRIPTION

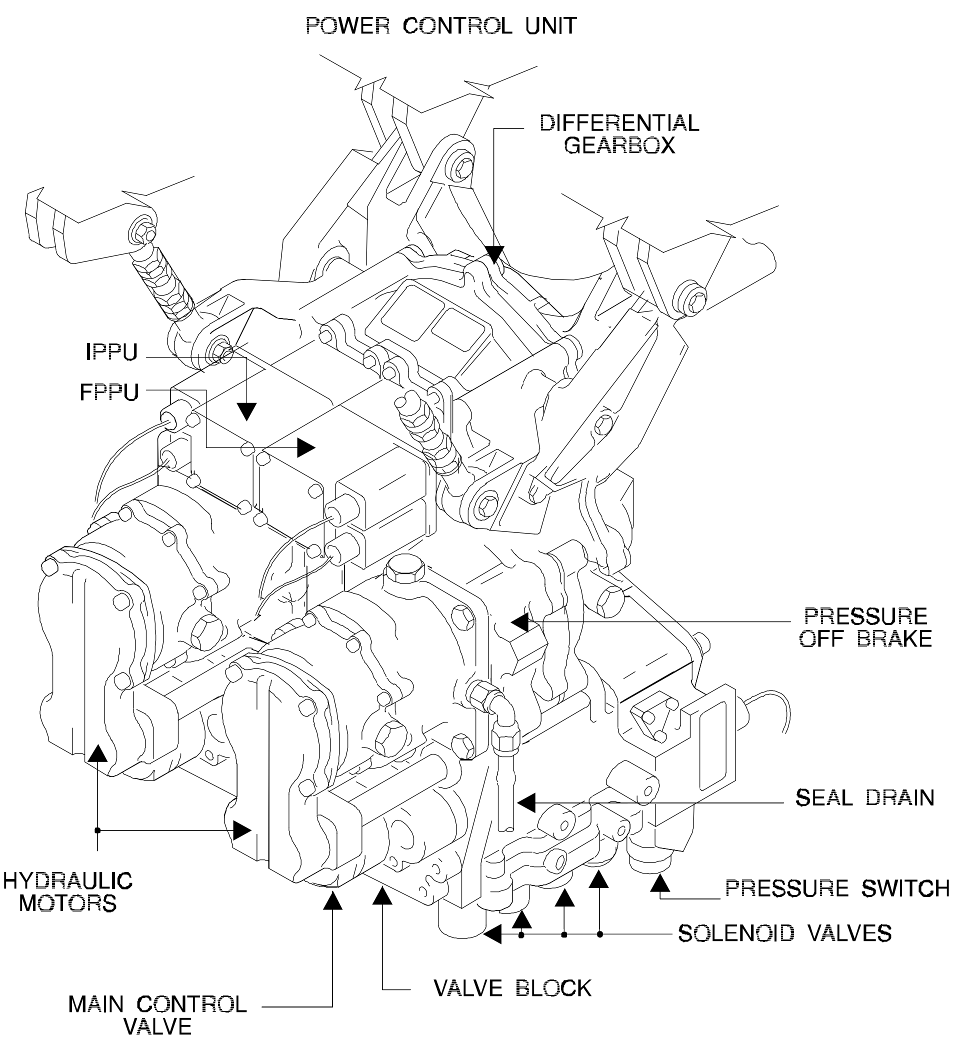
Each valve block includes :

- four solenoid valves
- a pressure switch
- a pressure maintaining valve
- a main control valve
- an inlet filter
- a pressure and a return port,
- an electrical connector.

REMOVAL INSTALLATION

Removal of the valve block requires prior removal of the hydraulic motor and transfer tubes.
The solenoid valves, pressure switch and supply hydraulic connectors are attached to the underside of the valve block and can be detached whilst the valve block remains in situ.
Access to the filter unit is obtained by removal of the inlet fitting.





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HYDRAULIC MOTORS

The multipiston hydraulic motors are differentially coupled and are each supplied by a separate hydraulic system through one valve block.

COMPONENT DESCRIPTION

Hydraulic fluid is directed to one of the two motor ports, the other port being connected to the return line.
The motor is lubricated by the hydraulic fluid.
Reversal of the inlet and return pressure results in a directional change of the output shaft rotation.
Fluid transfer from the valve block to the motor and POB is achieved through transfer tubes.

REMOVAL INSTALLATION

The ouput shaft of each motor is connected to a Pressure Off Brake.
The total assembly (motor and POB) is mounted on the differential gearbox casing and is retained with four bolts.
The motors and POBs are interchangeable with those fitted on the flap PCU.

PRESSURE OFF BRAKE

A Pressure Off Brake is attached to each motor and holds the motor output shaft when the corresponding valve block is not energized.

COMPONENT DESCRIPTION

The POB has a multiple friction disk pack which is disengaged when pressure is applied to the brake.
The POB can be tested on ground, via the MCDU, by the WTB/POB test.

REMOVAL INSTALLATION

Removal of the POB requires prior removal of the related hydraulic motor.

POSITION PICK OFF UNITS (IPPU AND FPPU)

A Feedback Position Pick off Unit (FPPU) and an Instrumentation Position Pick off Unit (IPPU) are mounted on the PCU gearbox casing.
The FPPU gives information about slat actual position to the SFCCs that use this data for system monitoring.
The Instrumentation PPU sends slat position data to the Flight Warning Computers for display on the ECAM.

FIN : FPPU 27CW
IPPU 3CN

ZONE : 148/190

COMPONENT DESCRIPTION

An intermediate gear transmits the movement from the PCU differential gearbox to the PPUs.
The PPUs are hermetically sealed and their internal gearing is lubricated for life.
They are identical to and interchangeable with the Asymmetry PPUs.
They are also interchangeable with the flap system PPUs.

REMOVAL INSTALLATION

Both Feedback PPU and Instrumentation PPU can be removed with the PCU in position on the aircraft.
PPU zero adjustement procedure is the same as that described for the Asymmetry PPUs.

SLAT DRIVE STATION COMPONENTS

Type A Actuator
Type B Actuator

TYPE A ACTUATOR

FIN : 5019CW/(5079CW)
5021CW/(5081CW)

ZONE : 521/621

COMPONENT DESCRIPTION

Type A actuators, installed on tracks 2 and 3, are coupled to the inboard slat section 1, via a lever/linkage mechanism.
They consist of a multi stage reduction gearing and an integrated torque limiting assembly.
They are larger in size and torque capacity than type B and have an additional stage reduction gear assembly.

SPECIAL DESIGN

An integrated torque limiting assembly protects the structure against torque generated during a system locking or jamming.
It is built with a preloaded setting value related to actuator type and loading requirement and a lock out indicator is provided.

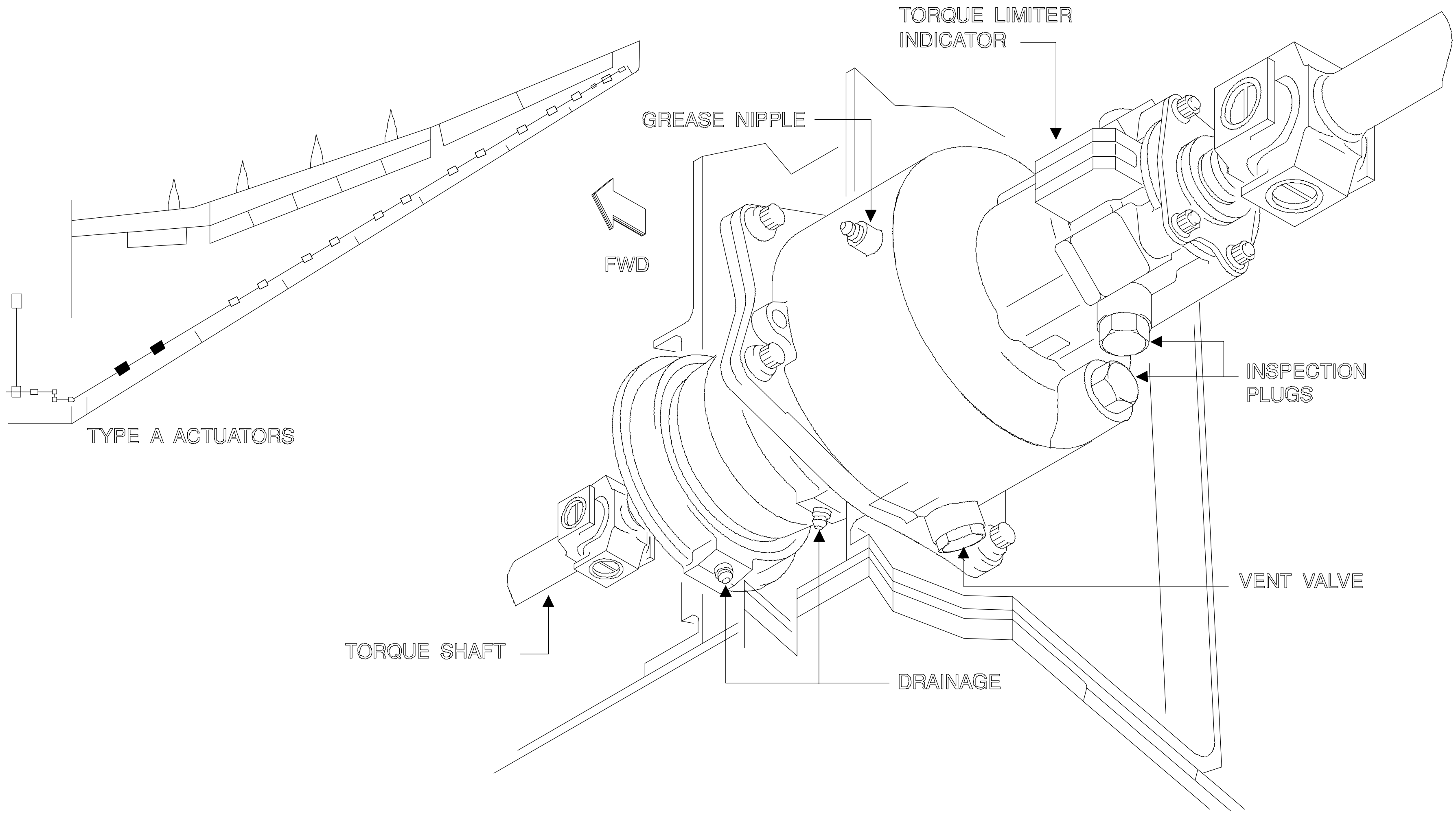
REMOVAL INSTALLATION

The type A actuators are fully interchangeable in their related positions wing to wing following a minor repositioning of the grease venting plugs.

SERVICING

Actuator A is designed for lubrication of the gear stages only, via a grease nipple, the torque limiter section remaining grease free.
A vent assembly allows surplus grease to exude.
It can be interchanged with the blanking plug to be in the lowest point when installing the actuator.

Inspection plugs are provided in the housing, two on the torque limiter chamber and two on the input gearing chamber, so that whatever the installed position on aircraft, the drainage is at the lowest point.
Lubricant condition can also be checked.



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TYPE B ACTUATOR

TYPE B	LH FIN	ZONE	RH FIN	ZONE
0	5027CW	522	5087CW	622
1	5029CW	"	5089CW	"
2	5033CW	"	5093CW	"
3	5035CW	"	5095CW	"
4	5037CW	"	5097CW	"
5	5039CW	"	5099CW	"
6	5045CW	523	5105CW	623
7	5047CW	"	5107CW	"
8	5049CW	"	5109CW	"
9	5051CW	"	5111CW	"
10	5053CW	"	5113CW	"
11	5056CW	"	5116CW	"

COMPONENT DESCRIPTION

Type B actuators are coupled in pairs to the remaining slat surfaces 2 to 7, via a rack and pinion mechanism.
As type A actuators, they are pure torque devices but are of a different design configuration, being smaller in size and torque capacity and having a simplified gearing arrangement.

SPECIAL DESIGN

As type A actuators, an integrated torque limiter assembly is provided to protect the structure in case of overtorque or system jamming.
Although the torque requirements vary greatly from stations 3 to 14, a common setting is used, based on the requirements of station 3.

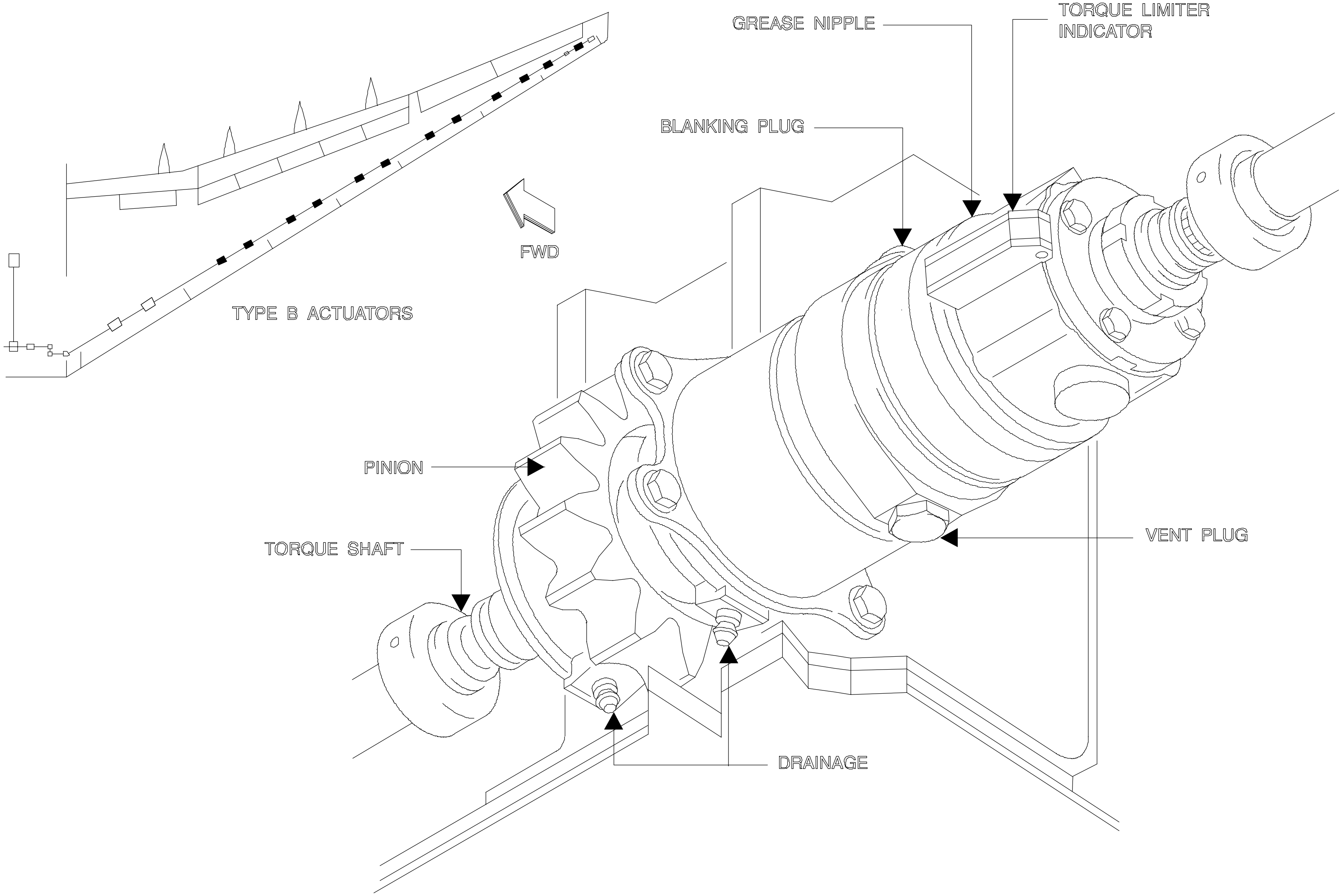
REMOVAL INSTALLATION

Type B actuators are fully interchangeable in their related positions wing to wing, following a minor repositioning of the grease venting plugs.

SERVICING

Actuator B is designed for lubrication of the gear stages only, via a grease nipple, the torque limiter section remaining grease free.
A vent assembly allows surplus grease to exude.
It can be interchanged with the blanking plug to ensure that it is in the lowest position when the actuator is installed on the A/C.

In the torque limiter housing, drainage holes are provided to prevent condensation to collect inside.
Drainage points are also provided at the flange mouting end of the actuator.



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STUDENT NOTES

SLAT TRANSMISSION COMPONENTS

Tee Gearbox
System Torque Limiter
Right Angle Gearbox
Bevel Gearbox
Wing Tip Brake (WTB)
Asymmetry Position Pick off Unit (APPU) Adaptor
Asymmetry Position Pick off Unit (APPU)
Torque Shafts
Steady Bearings

SAFETY PRECAUTIONS

WARNING :

PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :

- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING :

MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.

STUDENT NOTES

TEE GEARBOX

FIN : 5007CW

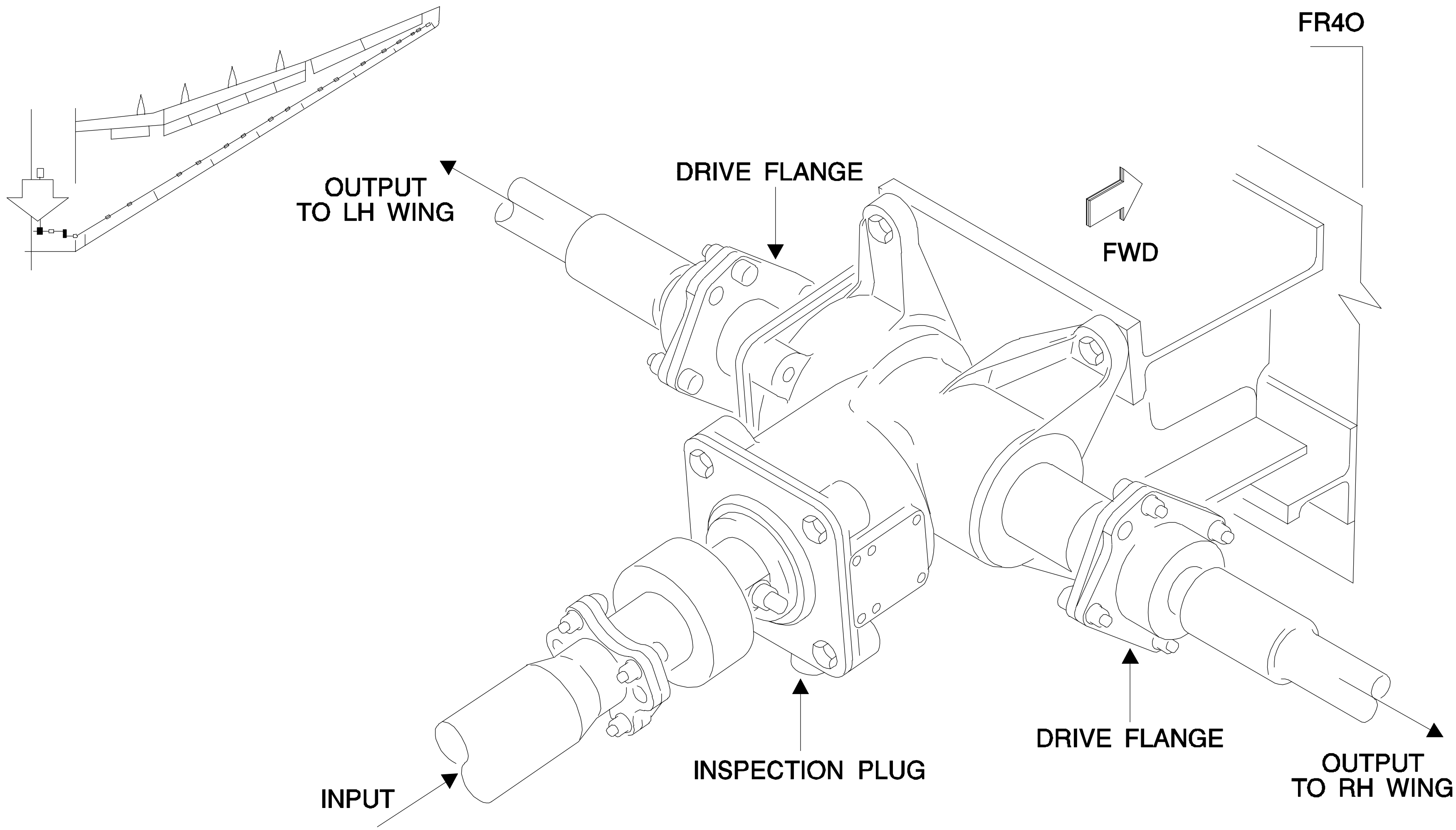
ZONE : 193

COMPONENT DESCRIPTION

The Tee gearbox transmits the torque from the PCU to the torque shafts. Its ratio is 1.3/1.
It consists of a T cast housing into which two bevel gear shafts are fitted.
Integral with the gearbox is a compliant shaft with drive flanges splined and pinned to retain the shaft.

SERVICING

Bolts attach the gearbox to the structure.
The gearbox is sealed and grease lubricated for life.
The bearings are lubricated on manufacture.
An inspection hole with a threaded plug allows the bearings and gears to be examined.



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SYSTEM TORQUE LIMITER

FIN : 5009CW/5069CW

ZONE : 191/192

COMPONENT DESCRIPTION

The system comprises a casing, a hexagonal input shaft, a special splined output shaft, a torque tube assembly (containing a preloaded torsion bar) and rollers.
The input and output shafts are interconnected through the torque tube assembly.

SPECIAL DESIGN

As on the flap system torque limiter, a lock out indicator is provided on the torque limiter body.
This indicator is released by thumb pressure when the torque limiter is reset.

SERVICING

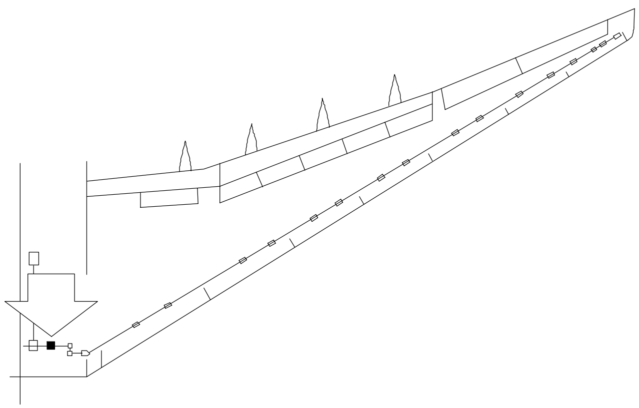
The casing is equipped with two drain plugs and a filler plug which allows lubrication with oil.

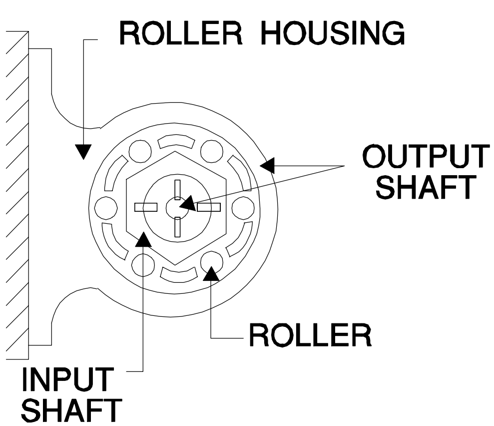
REMOVAL INSTALLATION

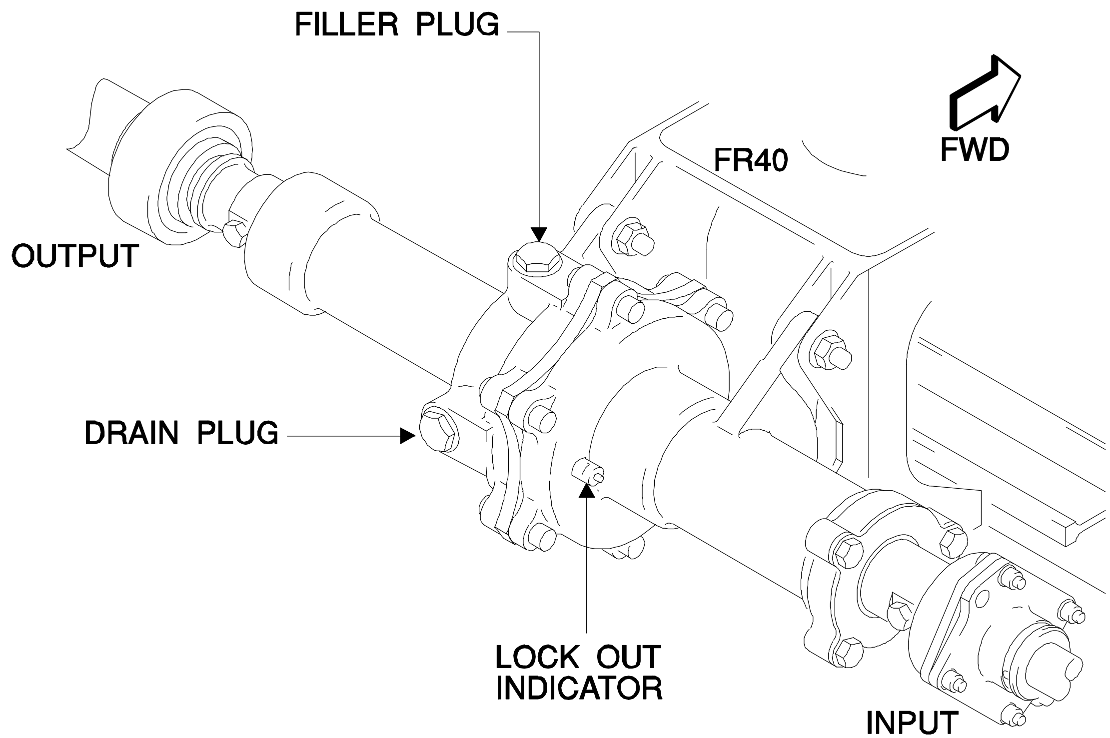
Bolts attach the housing to the structure.
The slat system torque limiters are identical to and fully interchangeable with the system torque limiters fitted on the flap transmission.

RESET

In case of an overload, the differential movement of the shafts causes the system to be locked by the rollers and the load is transmitted to the structure.
Resetting this condition is achieved by rotating in the opposite direction.







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RIGHT ANGLE GEARBOX

FIN : 5011/5013CW
5071/5073CW

ZONE : 191/192

COMPONENT DESCRIPTION

Two identical right angle gearboxes are installed in each wing to change alignment in the wing root area.
Bolts attach each gearbox to the structure.
The input and output shafts have splined ends for connection to the torque shafts and reversed lip seals to avoid unwanted material getting into the gearboxes.

SERVICING

The gearboxes are sealed and grease lubricated and there is no maintenance or lubrication scheduled.
Inspection plugs allow the lubricant to be examined.
These gearboxes used in slat and flap systems are identical and interchangeable.

BEVEL GEARBOX

FIN : 5015CW/5075CW

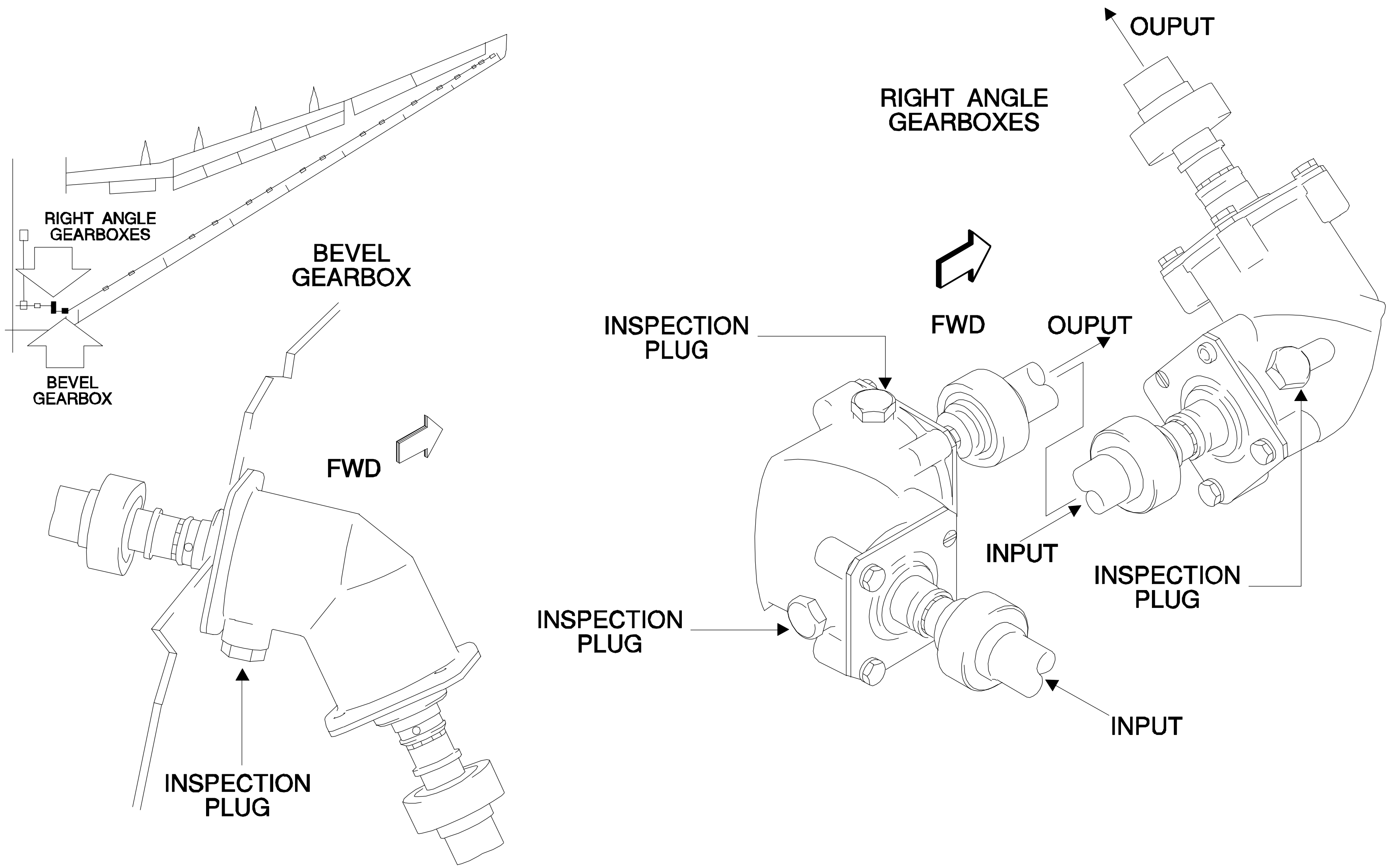
ZONE : 191/192

COMPONENT DESCRIPTION

One 53° bevel gearbox per wing, attached to the fuselage adjacent to the wing root, aligns the transmission with that of the wing leading edge.
The input and output shafts have splined ends for connection to the torque shafts and reverse lip seals to make sure that unwanted material doesn’t get into the gearbox.

SERVICING

The 53° bevel gearbox is sealed and grease lubricated.
The bearings and gears can be examined through inspection holes closed with threaded plugs.



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WING TIP BRAKE (WTB)

FIN : 33/34CW

ZONE : 523/623

COMPONENT DESCRIPTION

The brake is a "pressure off brake" using a multi plate friction device operated by a spring pack.
Brake release is performed by dual hydraulic pistons controlled by two electro hydraulic solenoid valves.
The two hydraulic circuits are separated and either one can release the brake.

SPECIAL DESIGN

Brake position is monitored by a proximity sensor used on ground for the WTB engagement test performed from the MCDU.
In addition, a manual brake release mechanism is provided for maintenance operation.

Note : flap WTB shown, slat WTB identical.

MAINTENANCE PRACTICE

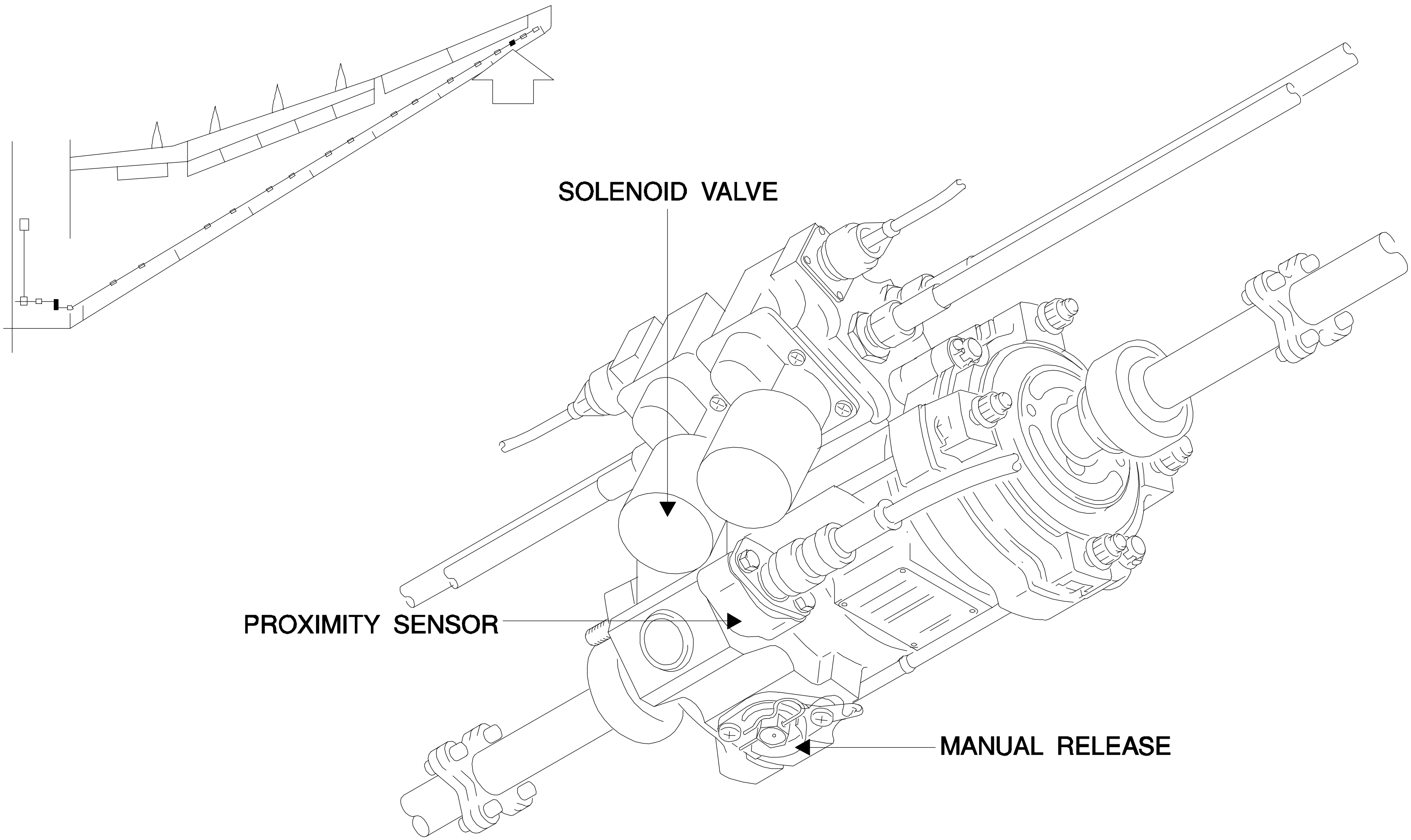
Manual release is achieved by rotating the manual release shaft in an anticlockwise direction.
- first withdraw the spring cotter pin, then rotate the release shaft until the indicator arm moves to the "M" (Maintenance) position.

At this point, the brake is off and the transmission through shaft can be rotated.
- Setting the brake to the operational position again is performed by rotating the release shaft clockwise, until the indicator arm is in the "0" (Operational) position.

The release shaft must be in the correct operational position, so that the spring cotter pin can be re-inserted.

REMOVAL INSTALLATION

The solenoid valves and proximity sensor are self contained LRUs.
The slat wing tip brakes are fully interchangeable with those fitted on the flap system.



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ASYMMETRY POSITION PICK OFF UNIT (APPU) ADAPTOR

FIN : 5058/5118CW

ZONE : 523/623

COMPONENT DESCRIPTION

The APPU adaptor attaches the APPU to the slat transmission system.
It is provided with a foolproofing plate which prevents its removal when the APPU is installed.

SERVICING

To gain access to the adaptor fixing bolts, you must remove the Asymmetry PPU and rotate the foolproofing plate by unscrewing the plate locking screws.
Rotating the plate aligns access holes and bolt heads.

ASYMMETRY POSITION PICK OFF UNIT (APPU)

FIN : 29/30CW

ZONE : 523/623

COMPONENT DESCRIPTION

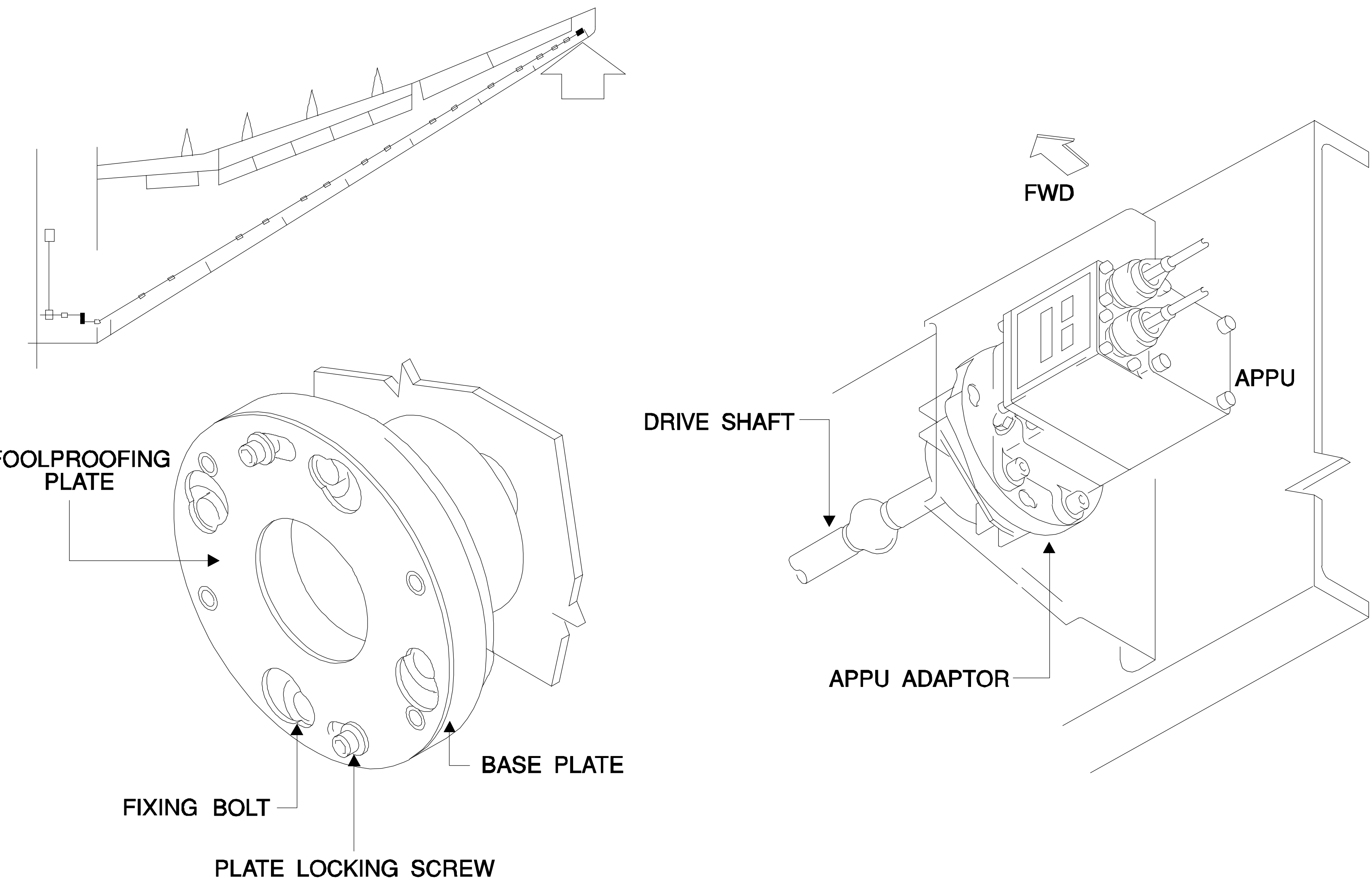
Each APPU consists of duplicated synchros driven by a single input shaft through a reduction gearing.
The electrical connector block, attached to the reduction gear housing, has two connectors, each dedicated to one synchro transmitter.
The turn of the input shaft through 360 revolutions gives 360° synchro output.
For full slat travel, the angular output of each synchro is 228°.

SPECIAL DESIGN

A transparent window, located in the cover plate allows zero adjustment through a system of matching marker lines, in the casing and on the rotating shaft.

REMOVAL INSTALLATION

Each APPU is mounted on the aircraft structure via an adaptor assembly.
The APPUs are identical to and interchangeable with the IPPU and the FPPU mounted on the slat PCU.
They are also interchangeable with the PPUs installed on the flap system.
They are hermetically sealed and their internal gearing is "life lubricated".



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TORQUE SHAFTS

COMPONENT DESCRIPTION

The torque shafts are equipped with universal or splined joints to allow angular changes of alignment.
The welded end fittings have a flange for a bolted joint or splines for a sliding end connection, the male part of which, has an indicator groove for indication of minimum acceptable engagement between the male and female part.

SPECIAL DESIGN

In addition, compliant shafts are installed in positions 1, 2, 4LH and 4RH, 58LH and 58RH.
The compliant shafts act as torsion dampers in the event of torque limiter lock out.

TORQUE SHAFT N°		FIN		ZONE
0		5002CW		143
1		5004CW		193
2		5006CW		193
	LH FIN	ZONE	RH FIN	ZONE
4	5008CW	193	5068CW	193
5	5010CW	191	5070CW	192
6	5012CW	191	5072CW	192
8	5014CW	191	5074CW	192
10	5016CW	521	5076CW	621
11	5018CW	521	5078CW	621
12	5020CW	521	5080CW	621
14	5022CW	521	5082CW	621
20	5024CW	521	5084CW	621
24	5026CW	522	5086CW	622
26	5028CW	522	5088CW	622
28	5030CW	522	5090CW	622
30	5032CW	522	5092CW	622
32	5034CW	522	5094CW	622
36	5036CW	522	5096CW	622
38	5038CW	522	5098CW	622
45	5065CW	522	5125CW	622
47	5067CW	523	5127CW	623
48	5046CW	523	5106CW	623
50	5048CW	523	5108CW	623
54	5050CW	523	5110CW	623
58	5052CW	523	5112CW	623
60	5054CW	523	5114CW	623
62	5055CW	523	5115CW	623
APPU DRIVE SHAFT	5057CW	523	5117CW	623

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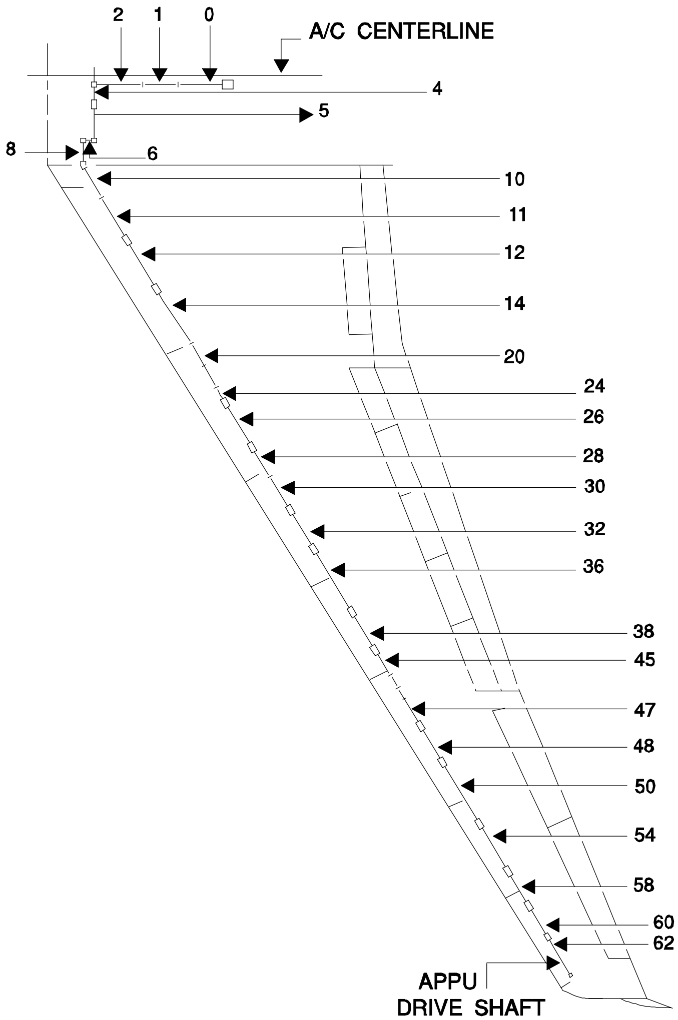

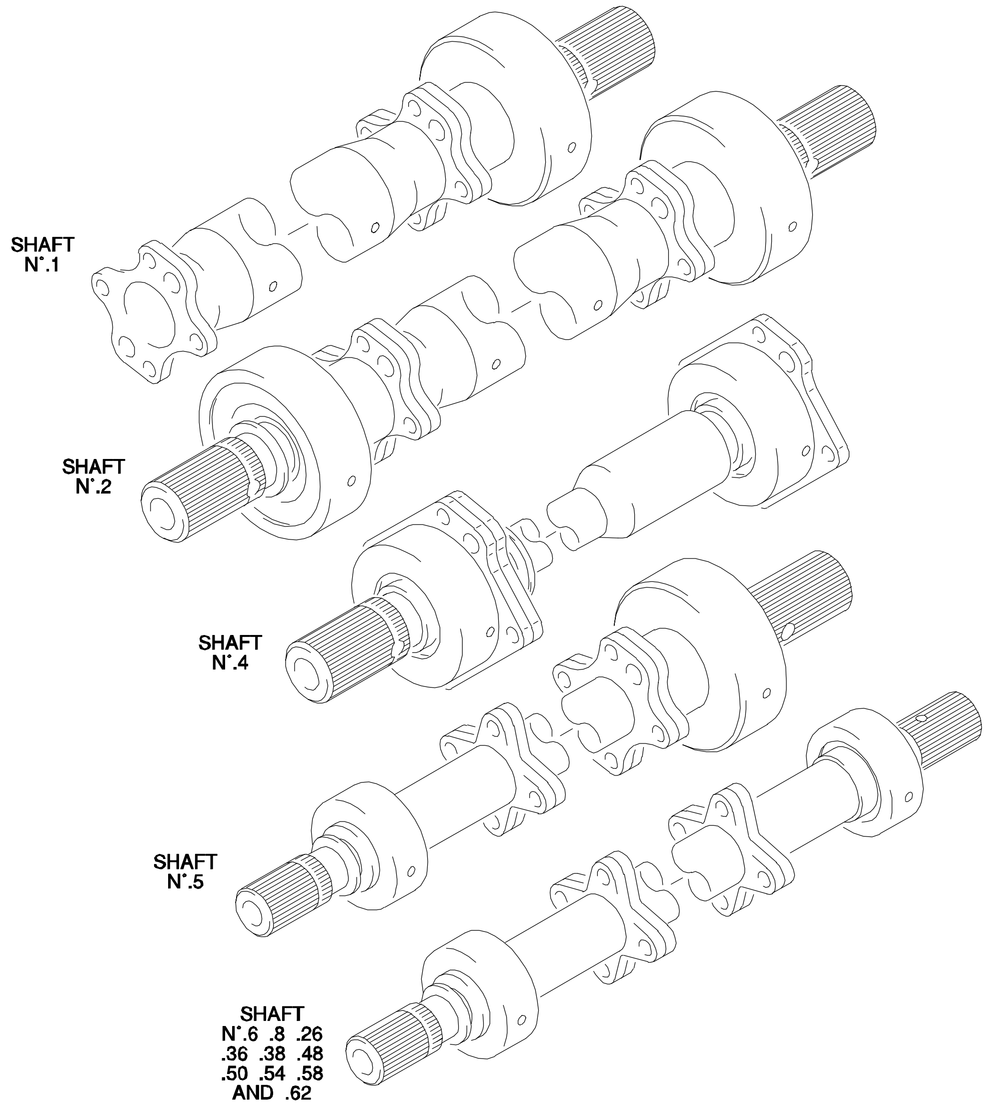

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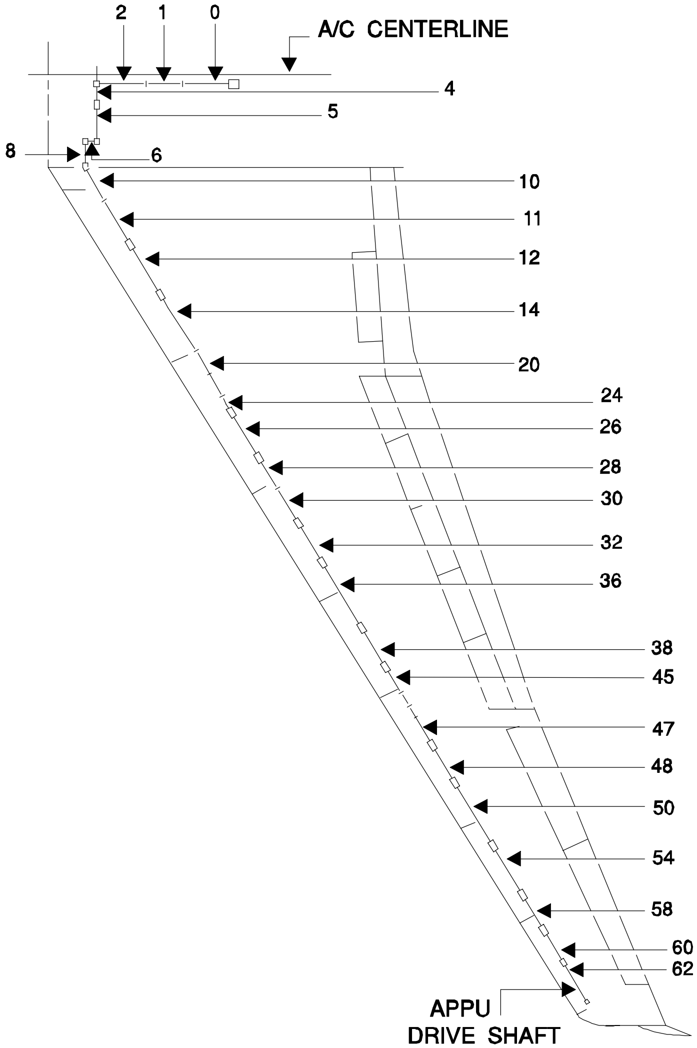

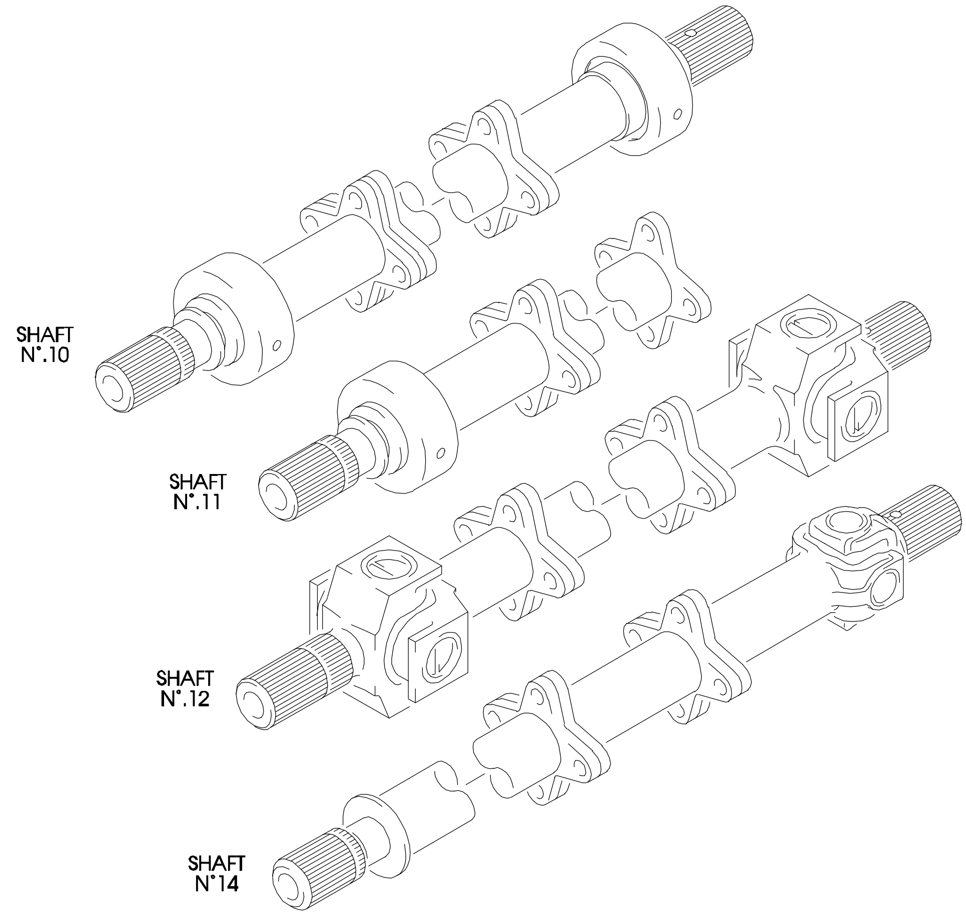

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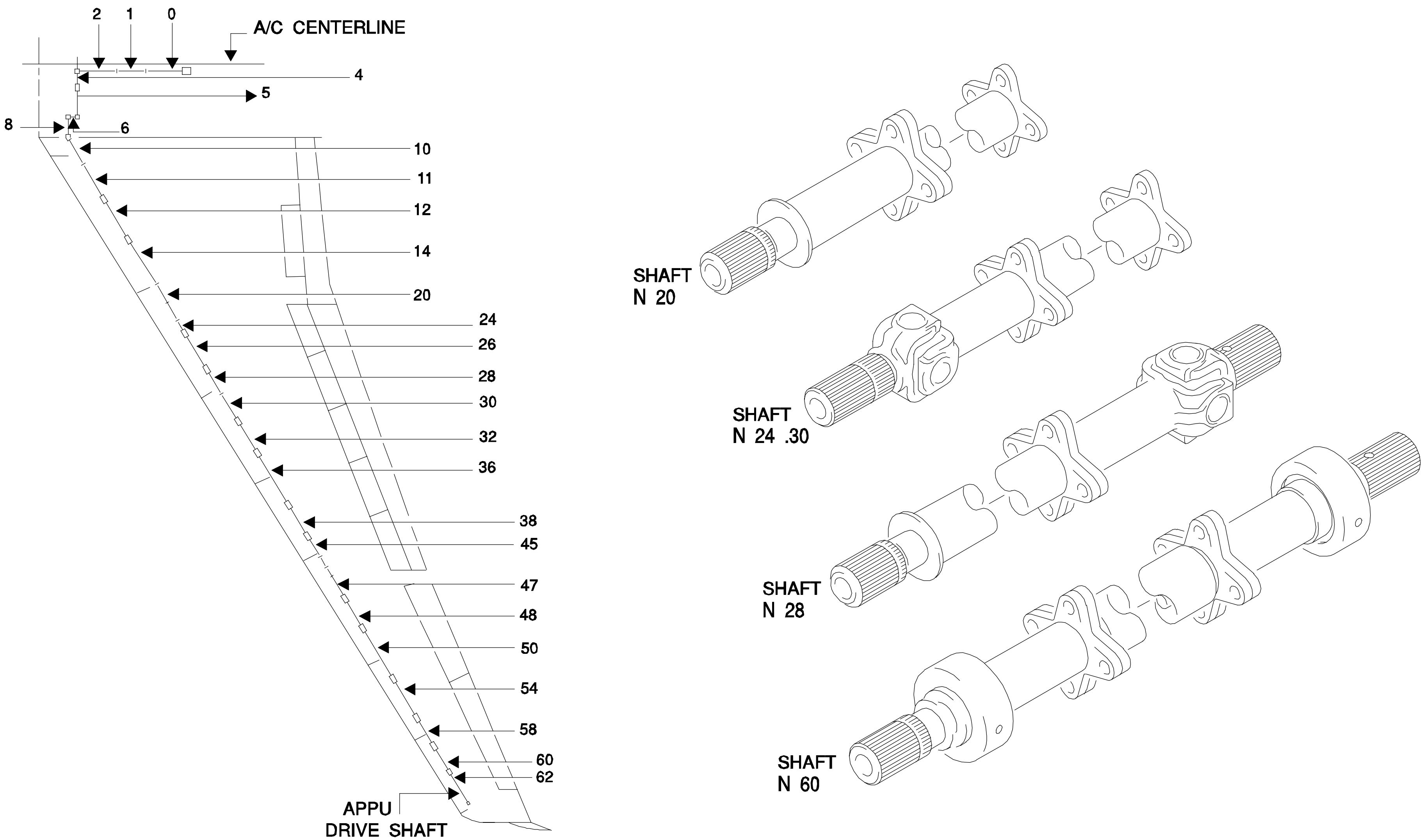

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STEADY BEARINGS

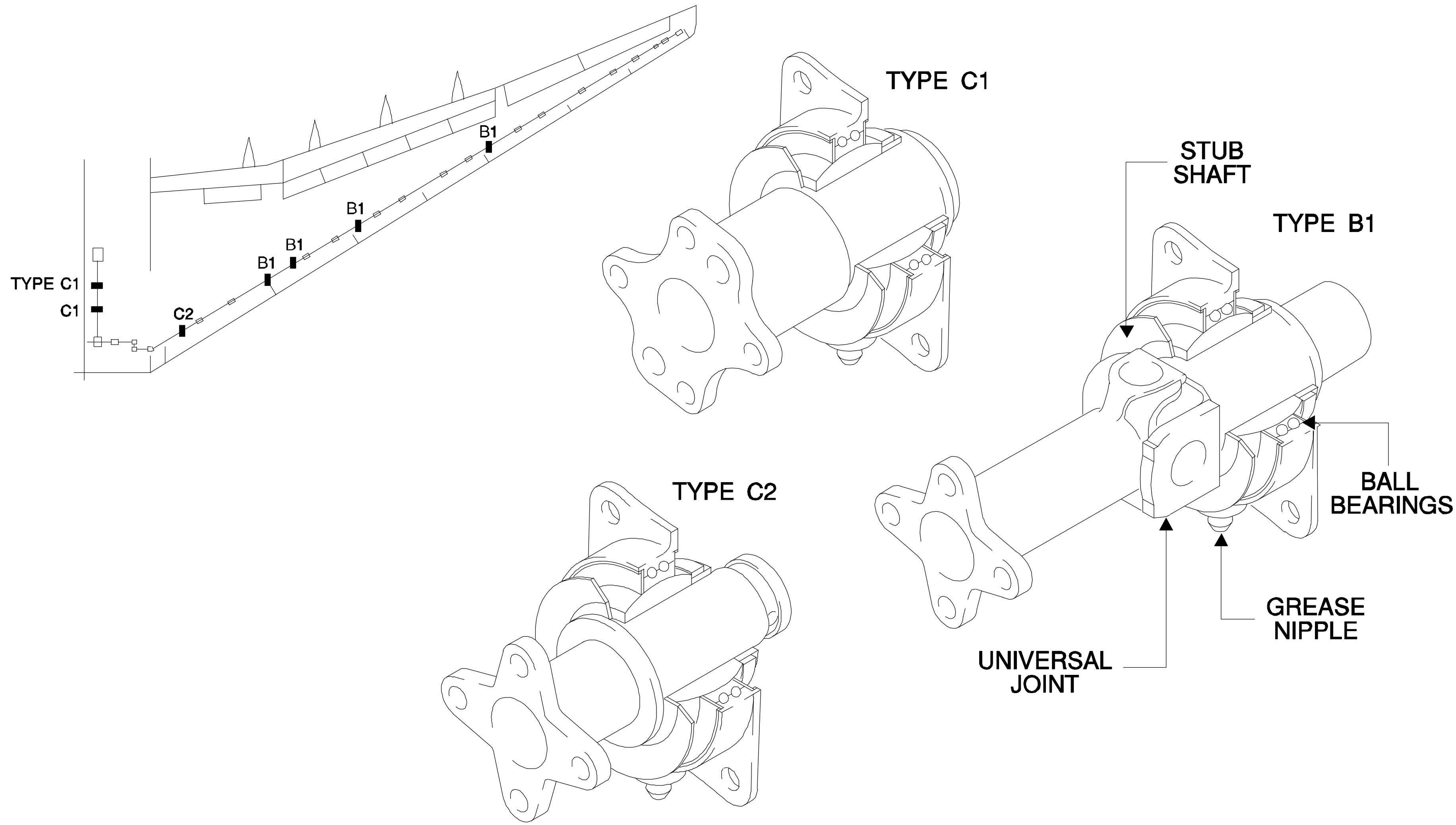
CENTER	FIN	5003	5005CW			
	ZONE	193	193			
LH	FIN	5017	5023	5025	5031	5066CW
	ZONE	521	521	522	522	522
RH	FIN	5077	5083	5085	5091	5126CW
	ZONE	621	621	622	622	622

COMPONENT DESCRIPTION

The steady bearings together with universal joints accomodate installation angles, wing deflections and shaft angular deviations.
Three types are used : types B1, C1 and C2.
They are similar using self aligning ball bearings. Type B1 is provided with a universal joint.

SERVICING

The self aligning ball bearings are grease lubricated and sealed.
A regreasing point is provided (nipple).



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STUDENT NOTES

FLAP POWER CONTROL UNIT COMPONENTS

Power Control Unit
Valve Blocks
Hydraulic Motors
Pressure Off Brakes
Position Pick off Units

POWER CONTROL UNIT

The flap Power Control Unit allows hydraulic actuation of the flap transmission system.
The following LRUs are attached to the PCU :

- two hydraulic motors
- two valve blocks
- eight solenoid valves
- two pressure switches
- two inlet filters
- one Feedback PPU
- one Instrumentation PPU.

FIN : 5000 CV

ZONE : 148

COMPONENT DESCRIPTION

The PCU casing contains a differential gearbox. This gearbox houses a reduction and differential gear which transmits the movement from the hydraulic motors to the flap transmission through an output final bevel gear assy incorporated in the PCU.

REMOVAL INSTALLATION

Apart from the valve block sub units, the bolts for the LRUs are accessible from a single face of the PCU.
Slat and flap PCUs are similar but are not interchangeable because of the final bevel gear assy and the mounting lugs which are different.

SERVICING

The differential gearbox is lubricated by oil. Oil filler/level and drain plugs are installed in accessible positions.

VALVE BLOCK

The total valve block assy is identified as a LRU and is secured to the gearbox casing by a three point attachment.
The two valve blocks are identical in all aspects and component parts are fully interchangeable for both the slat and flap PCUs.
The four solenoid valves of each valve block are the same and interchangeable.
They are not interchangeable with the Wing Tip Brake solenoid valves.

FIN : 23CV/24CV

ZONE : 148

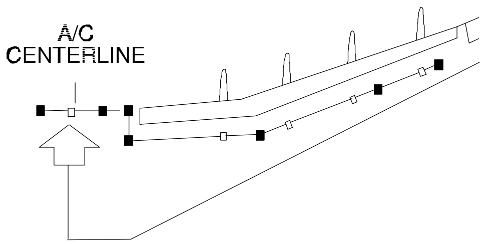
COMPONENT DESCRIPTION

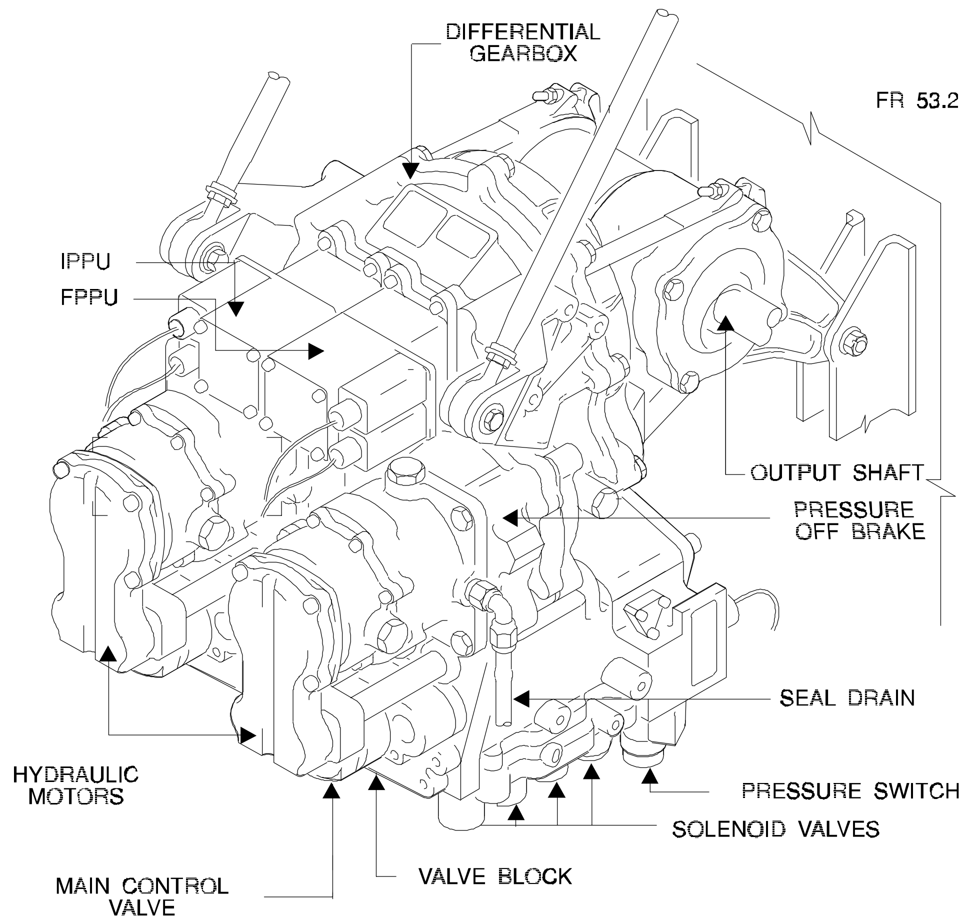
Each valve block includes :

- four solenoid valves
- a pressure switch
- a pressure maintaining valve
- a main control valve
- an inlet filter
- a pressure and a return port,
- an electrical connector.

REMOVAL INSTALLATION

Removal of the valve block requires prior removal of the hydraulic motor and transfer tubes.
The solenoid valves, pressure switch and supply hydraulic connectors are attached to the underside of the valve block and can be detached whilst the valve block remains in situ.
Access to the filter unit is obtained by removal of the inlet fitting.





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HYDRAULIC MOTORS

The multipiston hydraulic motors are differentially coupled and are each supplied by a separate hydraulic system through one valve block.

COMPONENT DESCRIPTION

Hydraulic fluid is directed to one of the two motor ports, the other port being connected to the return line. The motor is lubricated by the hydraulic fluid. Reversal of the inlet and return pressure results in a directional change of the output shaft rotation.

REMOVAL INSTALLATION

The ouput shaft of each motor is connected to a Pressure Off Brake. The total assembly (motor and POB) is mounted on the differential gearbox casing and is retained with four bolts.
The motors and POBs are interchangeable with those fitted on the slat PCU.

PRESSURE OFF BRAKE

A Pressure Off Brake is attached to each motor and holds the motor output shaft when the corresponding valve block is not energized.

COMPONENT DESCRIPTION

The POB has a multiple friction disk pack which is disengaged when pressure is applied to the brake.
The POB can be tested on ground, via the MCDU, by the WTB/POB test.

REMOVAL INSTALLATION

Removal of the POB requires prior removal of the related hydraulic motor.

POSITION PICK OFF UNITS

A Feedback Position Pick off Unit (FPPU) and an Instrumentation Position Pick off Unit (IPPU) are mounted on the PCU.
The FPPU gives information about flap actual position to the SFCCs, while the IPPU sends flap position data to the Flight Warning Computers.

FIN : FPPU 27CV
IPPU 3CF

ZONE : 148/140

COMPONENT DESCRIPTION

An intermediate gear transmits the movement from the PCU differential gearbox to the PPUs.
The FPPU and IPPU are identical to and interchangeable with the Asymmetry PPUs.
They are also interchangeable with the slat system PPUs.

REMOVAL INSTALLATION

Both Feedback PPU and Instrumentation PPU can be removed with the PCU in position on the aircraft.
PPU zero adjustement procedure is the same as that described for the Asymmetry PPUs.

FLAP DRIVE STATION COMPONENTS

Down Drive Gearbox
Down Drive Shaft
Input Bevel Gearbox
Cross Shaft
Rotary Actuator

SAFETY PRECAUTIONS

WARNING:

PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR:

- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING:

MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING:

MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING:

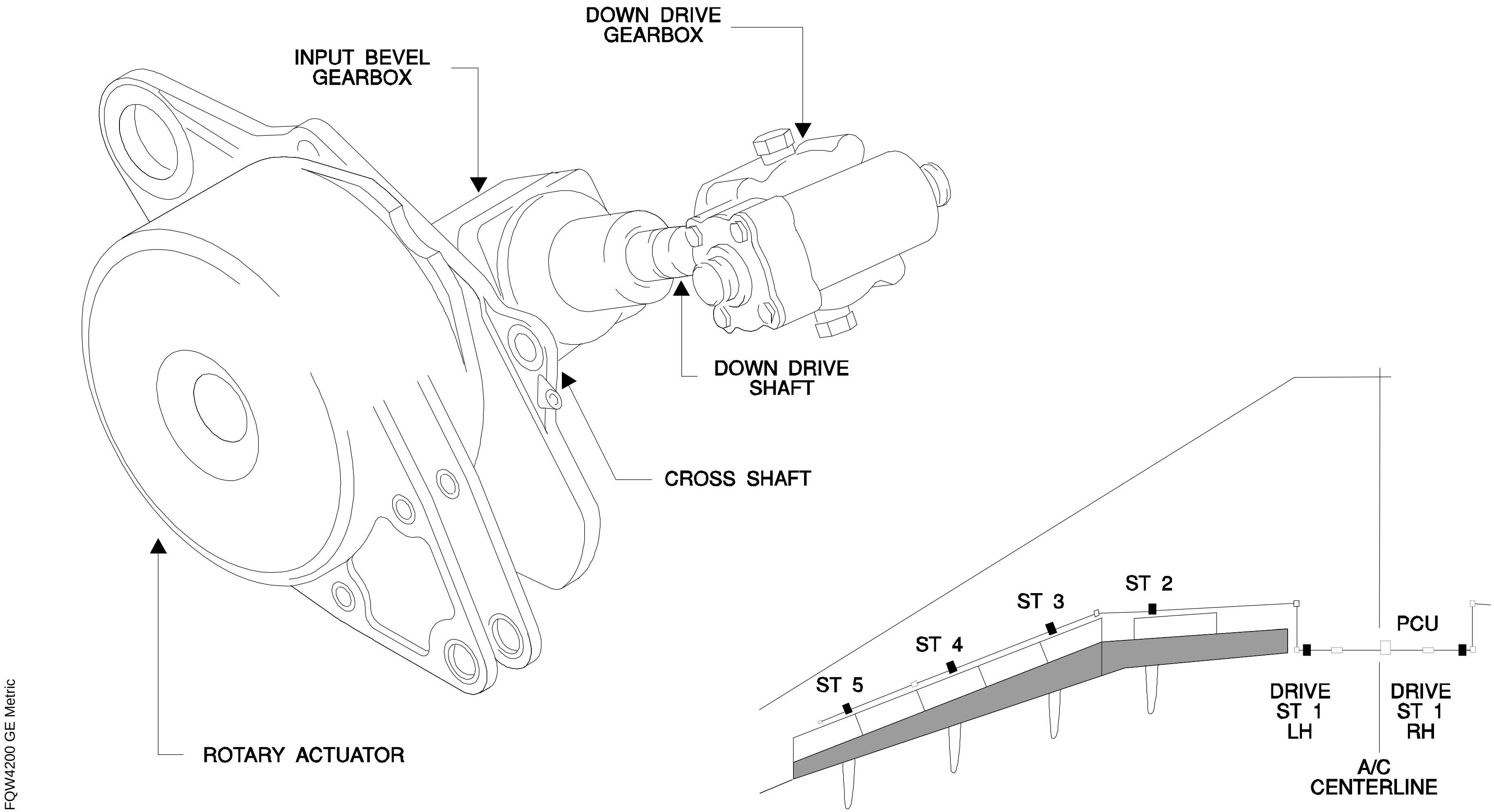
MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.

GENERAL

Each drive station includes :

- a down drive gearbox,
- a down drive shaft,
- an input bevel gearbox,
- a cross shaft,
- a flap rotary actuator.

Each drive station is interchangeable between LH and RH wings and its overall ratio is approximately 1/931.


DOWN DRIVE GEARBOX
INPUT BEVEL GEARBOX
DOWN DRIVE SHAFT
CROSS SHAFT
ROTARY ACTUATOR
ST 2
ST 3
ST 4
ST 5
PCU
DRIVE ST 1 LH
DRIVE ST 1 RH
A/C CENTERLINE
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DOWN DRIVE GEARBOX

The down drive gearbox transfers the power from the torque shafts to the input bevel gearbox through a cross shaft.

FIN / ZONE

LH	ST1	ST2	ST3	ST4	ST5
FIN	5005CV	5020CV	5030CV	5040CV	5051CV
ZONE	147	531	532	533	534

RH	ST1	ST2	ST3	ST4	ST5
FIN	5083CV	5098CV	5108CV	5118CV	5129CV
ZONE	148	631	632	633	634

COMPONENT DESCRIPTION

There are two types of down drive gearboxes :

- Type A has a shaft angle of 84 and is used at stations 1, 3, 4 and 5.
- Type B has a shaft angle of 93.3 and is used at station 2.

Both types are of similar construction and have the same ratio.

REMOVAL INSTALLATION

To remove the gearbox, the mating transmission shafts and related down drive shaft have to be disconnected first.
The gearbox input and output shafts have splined ends and reversed lip seals.

SERVICING

The gearboxes are sealed and grease-lubricated.
Their bearings are shielded and can not be relubricated.
Inspection plugs are provided, which can be used to drain any liquid contents or to add lubricant if a fault is suspected.

DOWN DRIVE SHAFT

The down drive shaft carries the drive from the down drive gearbox to the input bevel gearbox and accomodates misalignment between these units through crowned splines.

FIN / ZONE

LH	ST1	ST2	ST3	ST4	ST5
FIN	5006CV	5021CV	5031CV	5041CV	5052CV
ZONE	147	531	532	533	534

RH	ST1	ST2	ST3	ST4	ST5
FIN	5084CV	5099CV	5109CV	5119CV	5130CV
ZONE	148	631	632	633	634

COMPONENT DESCRIPTION

Two types of drive shafts are found :

- Type A is installed at drive station 1.
- Type B is installed at drive stations 2, 3, 4, 5.

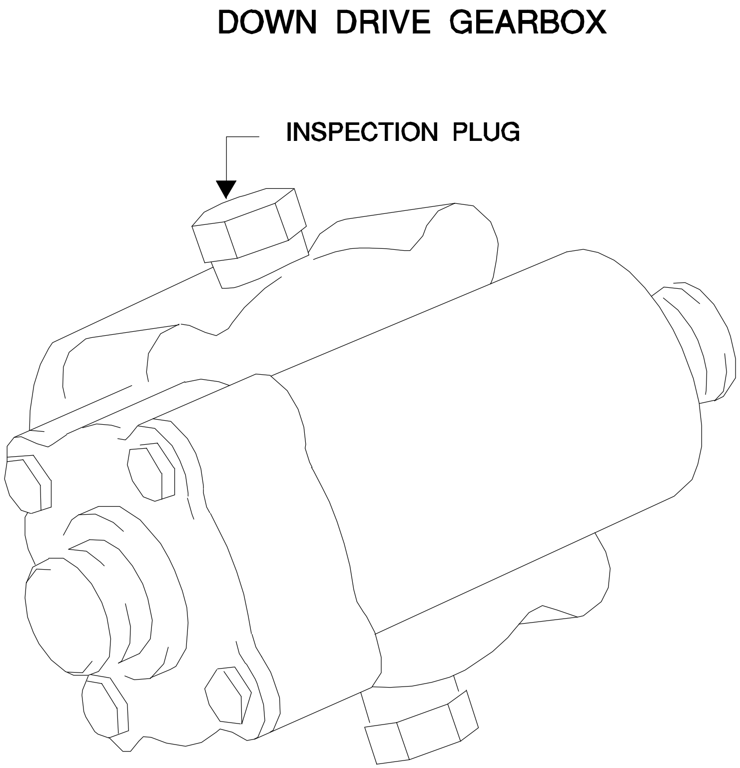
Both types are identical apart from their length which prevents incorrect installation.

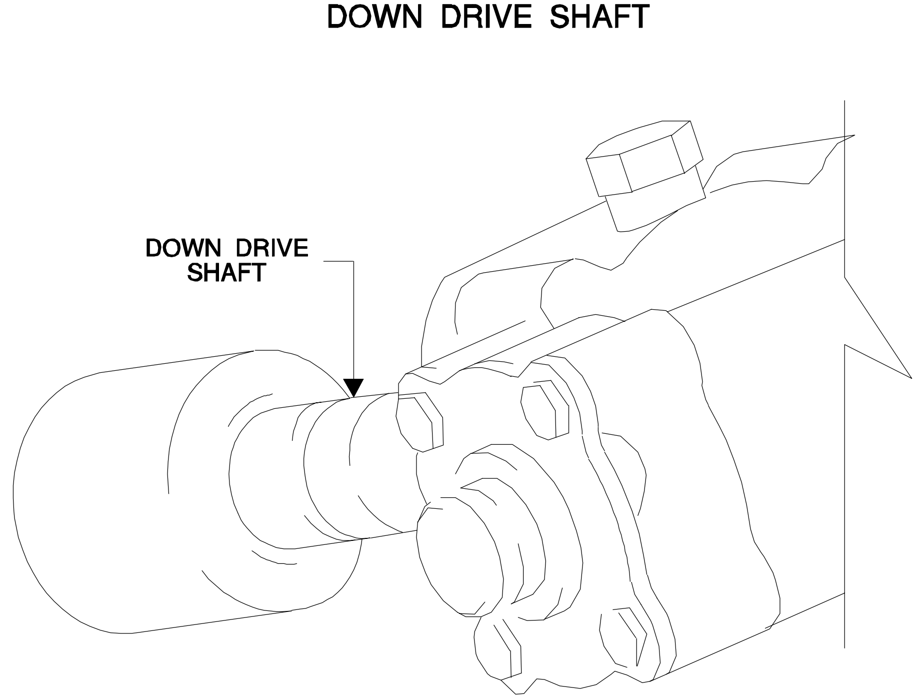
REMOVAL INSTALLATION

The shaft is fixed to the input bevel gearbox by a cross pin retained by a spiral ring.
To disconnect the shaft, the pin and ring must be removed first.
The shaft cannot be removed without removing the down drive gearbox or input bevel gearbox.

SERVICING

The splines are lubricated on installation.





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INPUT BEVEL GEARBOX

The input bevel geabox transmits the power from the down drive gearbox to the actuator through a cross shaft.

FIN / ZONE

LH	ST1	ST2	ST3	ST4	ST5
FIN	5007CV	5022CV	5032CV	5042CV	5053CV
ZONE	147	531	532	533	534

RH	ST1	ST2	ST3	ST4	ST5
FIN	5085CV	5100CV	5110CV	5120CV	5131CV
ZONE	148	631	632	633	634

COMPONENT DESCRIPTION

Each gearbox is made up of a torque limiter and an output bevel gearbox.
The gearbox shaft angle is 90° and ratio 1/20.
The input and output shafts have splined ends and reversed lip seals.

SPECIAL DESIGN

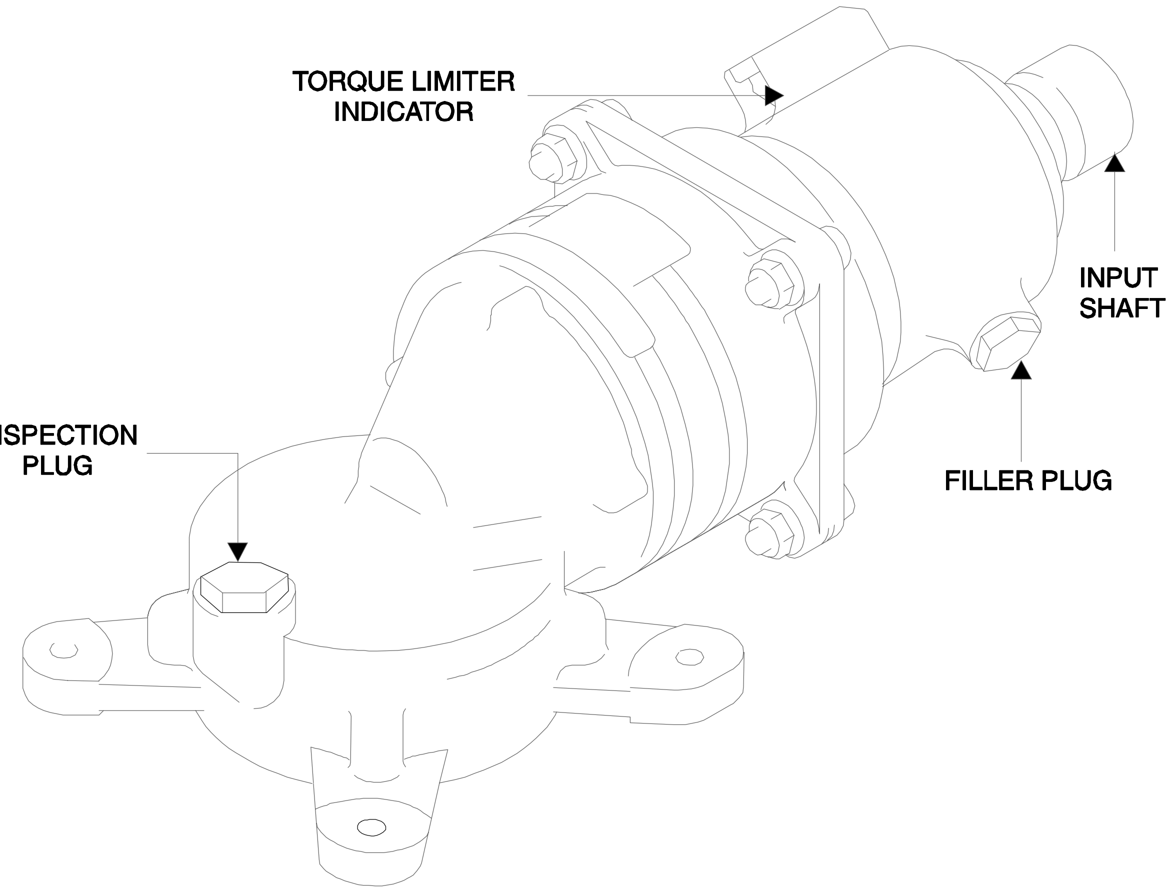
The latch type torque limiter indicator pops out if overtorque occurs.
It can be set again on ground by thumb pressure.

REMOVAL INSTALLATION

Because each station has its own torque limiter setting, the gearboxes are not interchangeable and are provided with different mounting hole positions.
Removal or installation cannot be achieved without disconnecting the down drive shaft first.

SERVICING

The input bevel gearboxes are sealed and grease lubricated.
Their bearings are shielded and cannot be relubricated.
An inspection plug is provided to drain any liquid content.



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CROSS SHAFT

The cross shaft carries the drive from the input bevel gearbox to the actuator and accomodates misalignment between these units via two crowned splines.

FIN ZONE

LH	ST1	ST2	ST3	ST4	ST5
FIN	5008CV	5023CV	5033CV	5043CV	5054CV
ZONE	147	531	532	533	534

RH	ST1	ST2	ST3	ST4	ST5
FIN	5086CV	5101CV	5111CV	5121CV	5132CV
ZONE	148	631	632	633	634

COMPONENT DESCRIPTION

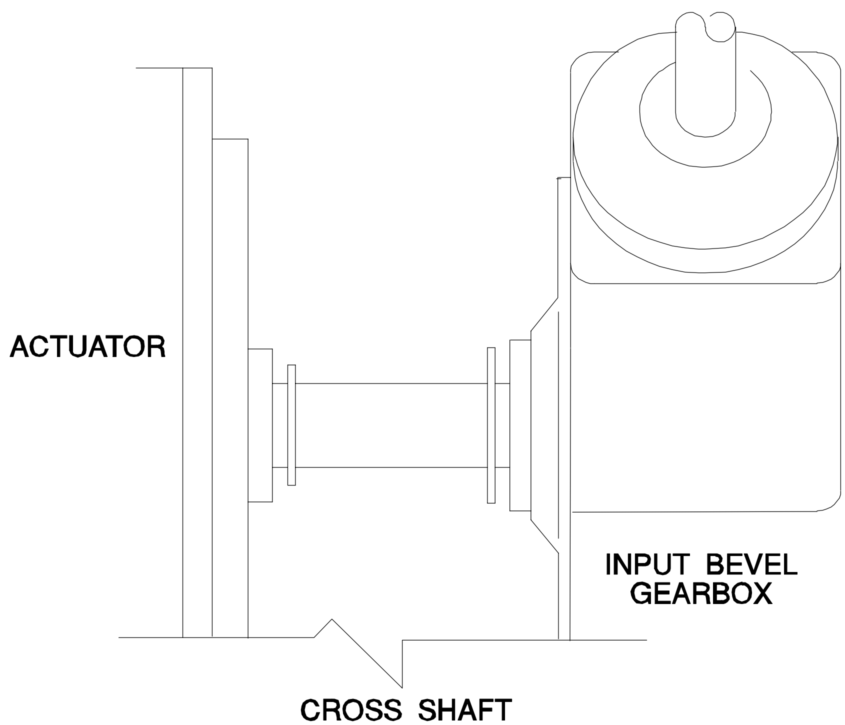
There are four types of cross shafts :

- Type A is used at station 1.
- Type B is used at station 2.
- Type C is used at stations 3 and 4.
- Type D is used at station 5.

Apart from their length and foolproofing features, the shafts are identical.

REMOVAL INSTALLATION

The shafts have a different spline size at each end to ensure that they are always assembled the same way round.
Removal of a cross shaft can only be achieved by first removing either its related actuator or input bevel gearbox.



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ROTARY ACTUATOR

The reduction ratio rotary actuators mounted on the track beams drive the flaps.
Each actuator has an output arm attached either directly to the flap drive linkage (station 1), or to an extension arm connected to the drive linkage. Each actuator has a gear ratio of 1/220.

FIN ZONE

LH	ST1	ST2	ST3	ST4	ST5
FIN	5009CV	5024CV	5034CV	5044CV	5055CV
ZONE	147	531	532	533	534

RH	ST1	ST2	ST3	ST4	ST5
FIN	5087CV	5102CV	5112CV	5122CV	5133CV
ZONE	148	631	632	633	634

COMPONENT DESCRIPTION

There are two types of rotary actuator :

- Type A is used at stations 1 and 5.
- Type B, which is of a larger diameter is installed at stations 2, 3 and 4 because of higher aerodynamic loads at these points.

Both types consist of an input and output stage installed in a forged steel casing.

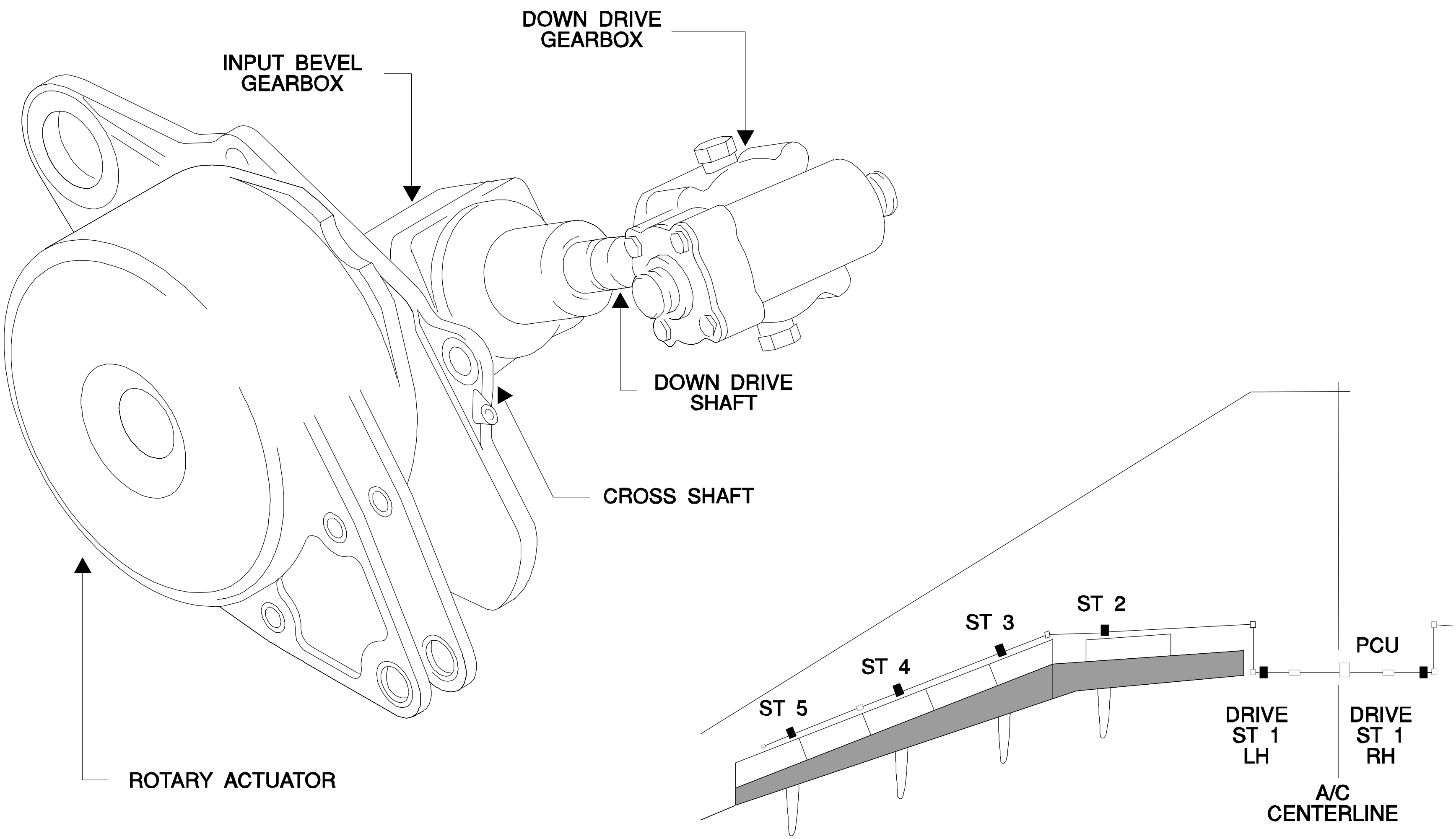
REMOVAL INSTALLATION

The actuators are common to both the left and right wings and to all applicable drive stations.
Each actuator is provided with four possible stop positions, two of which are used only.
The position of the stops differs according to the installation and is identified on the actuator casing.

Each actuator has also two possible vent positions, the unused one being blanked off.
The vent position depends on the actuator and each actuator casing is marked appropriately.

SERVICING

The actuators are designed to be "regreased" periodically through a grease nipple after removal of the vent/drain plug.



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STUDENT NOTES

FLAP TRANSMISSION COMPONENTS

System Torque Limiter
Right Angle Gearbox
Kink Bevel Gearbox
Wing Tip Brake (WTB)
Asymmetry Position Pick off Unit (APPU) Adaptor
Asymmetry Position Pick off Unit (APPU)
Torque Shafts
Steady Bearings

SAFETY PRECAUTIONS

WARNING :

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- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS

WARNING :

MAKE SURE THAT THE TRAVEL RANGES OF THE SURFACES ARE CLEAR BEFORE YOU PRESSURIZE/DEPRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE CONTROLS AGREE WITH THE POSITION OF THE ITEMS THEY OPERATE BEFORE YOU PRESSURIZE A HYDRAULIC SYSTEM.

WARNING :

MAKE SURE THAT THE LANDING GEAR SAFETY LOCKS AND THE WHEEL CHOCKS ARE IN POSITION.

STUDENT NOTES

SYSTEM TORQUE LIMITER

FIN : 5003CV/5081CV

ZONE : 147/148

COMPONENT DESCRIPTION

The system torque limiter comprises a housing, a hexagonal input shaft, a splined special output shaft, a torque tube assembly and rollers.

The input and output shafts are interconnected through a preloaded system (torque tube assy).

SPECIAL DESIGN

A lock out indicator is provided on the torque limiter body and is released by thumb pressure when the torque limiter is reset.

SERVICING

Two drain plugs and a filler plug are provided for system torque limiter servicing.

REMOVAL INSTALLATION

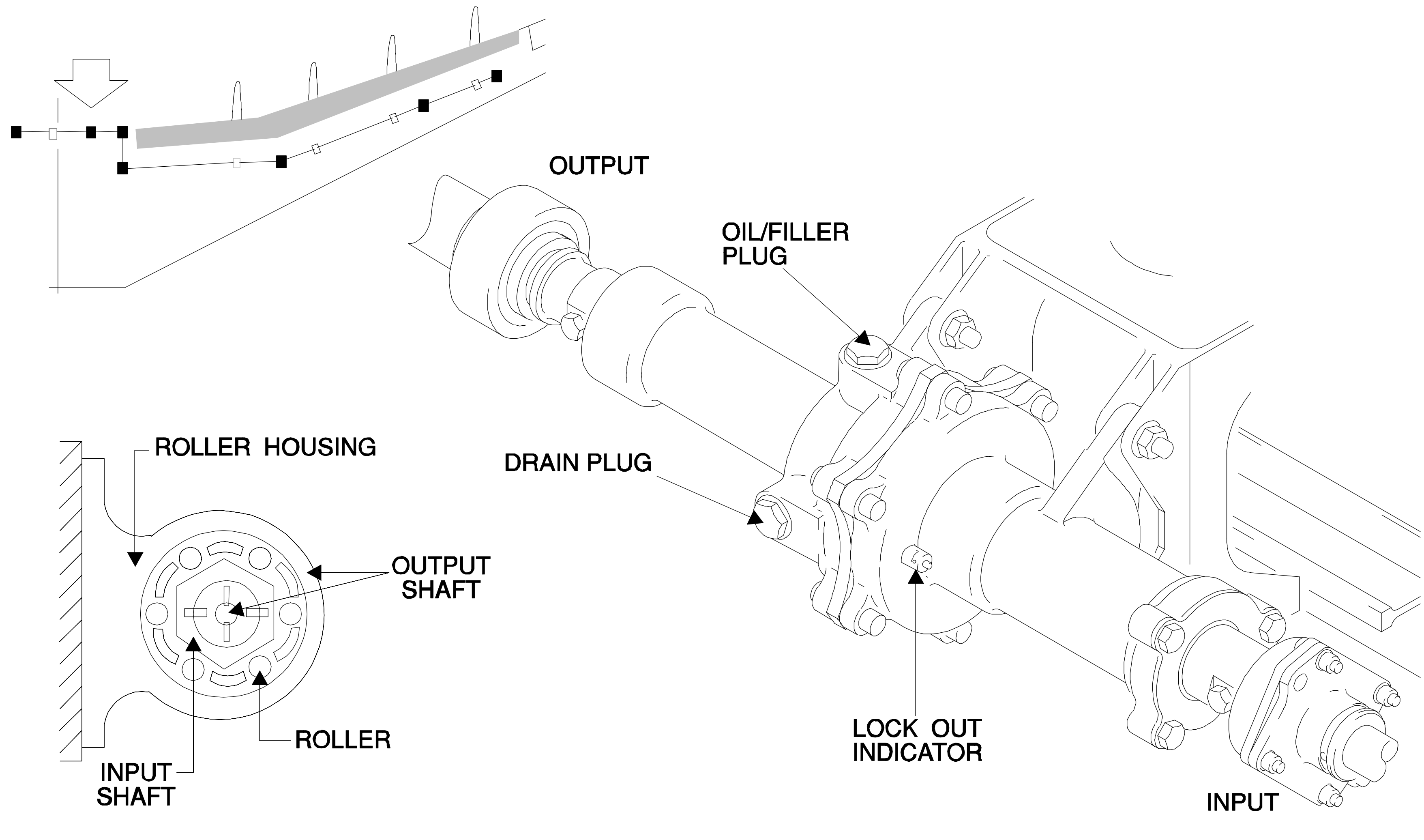
Bolts attach the housing to the structure.

The flap system torque limiters are identical to and fully interchangeable with the system torque limiters fitted on the slat transmission.

RESET

In the event of overload, the differential movement of the shafts causes the system to be locked by the rollers and the load is transmitted to the structure.

Resetting this condition is performed by rotating in the opposite direction, in flight ("S/F lever recycle") or on ground.



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RIGHT ANGLE GEARBOX

FIN : 5010CV / 5012CV
5088CV / 5090CV

ZONE : 147 / 571
148 / 671

COMPONENT DESCRIPTION

Two identical right angle gearboxes are installed in each wing to change alignment in the wing root area.
Bolts attach each gearbox to the structure.
The input and output shafts have splined ends for connection to the torque shafts and reversed lip seals to avoid unwanted material getting into the gearboxes.

SERVICING

The gearboxes are sealed and grease lubricated and there is no maintenance or lubrication scheduled.
Inspection plugs allow the lubricant to be examined.

KINK BEVEL GEARBOX

FIN : 5028CV/5106CV

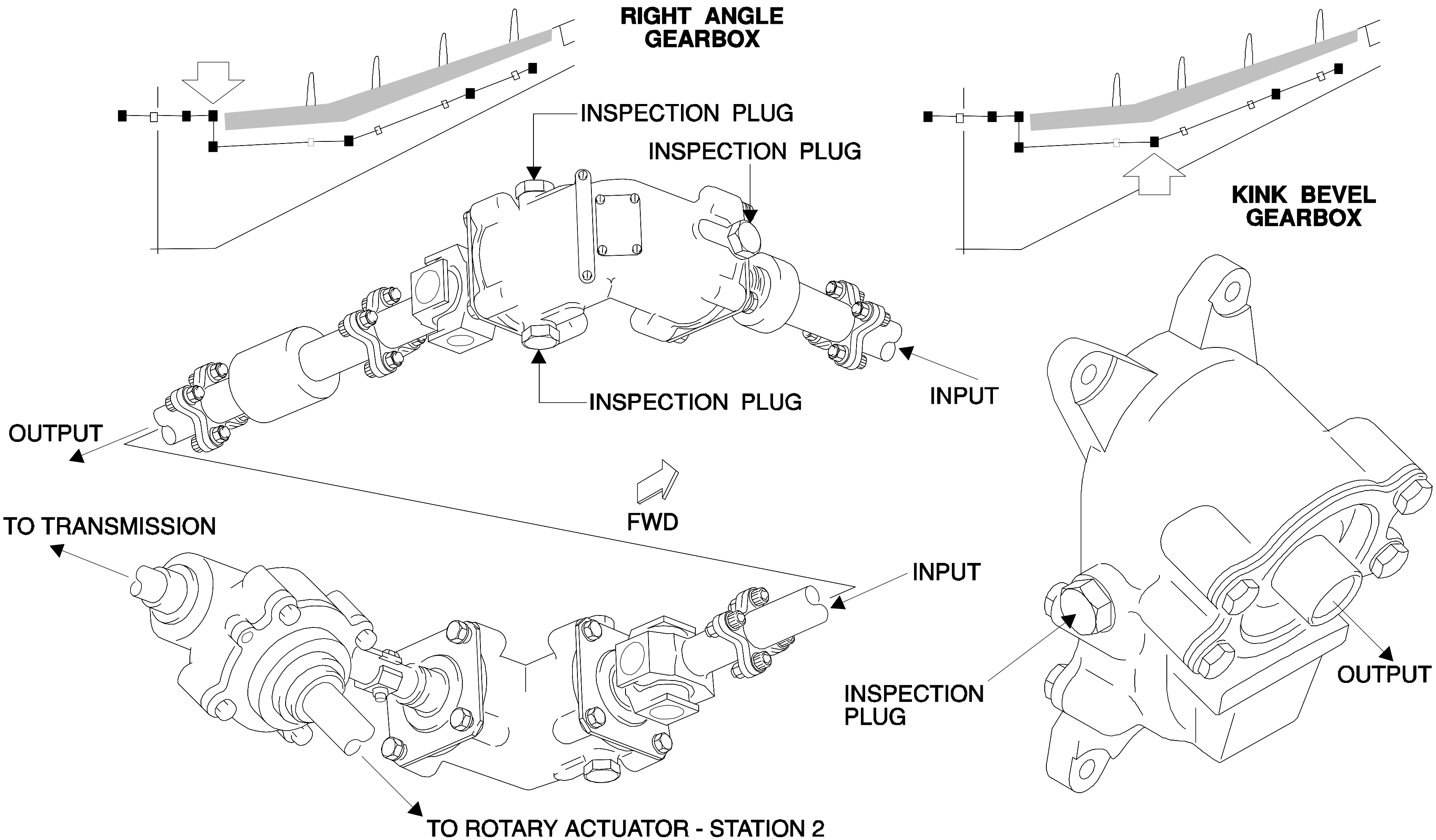
ZONE : 573/673

COMPONENT DESCRIPTION

A kink gearbox installed between drive stations 2 and 3 in each wing accomodates the change of alignment of the transmission and reverses the direction of rotation of the transmission shafting.
Its shaft angle is 21° and its ratio 1/1.

SERVICING

The kink bevel gearbox is sealed and grease lubricated but is provided with inspection plugs so as to drain any liquid contents or add lubricant if a fault is suspected.



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WING TIP BRAKE

FIN : 33CV/34CV

ZONE : 574/674

COMPONENT DESCRIPTION

The brake is a "pressure off brake" using a multiplate friction device operated by a spring pack.
Brake release is performed by dual hydraulic pistons controlled by two electro hydraulic solenoid valves.
The two hydraulic circuits are separated and either one can release the brake.

SPECIAL DESIGN

Brake position is monitored by a proximity sensor used on ground for the WTB engagement test performed from the MCDU, the associated electronic module being contained within the SFCC.
In addition, a manual brake release mechanism is provided for maintenance operation.

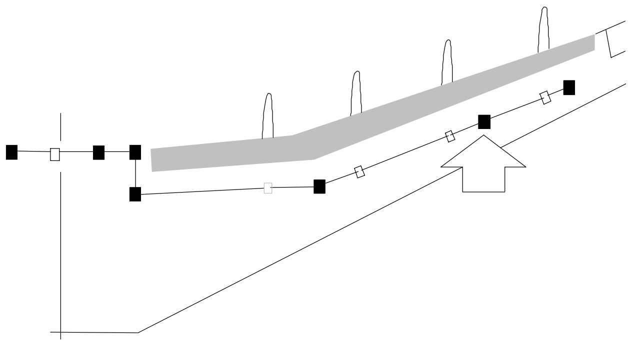
MAINTENANCE PRACTICE

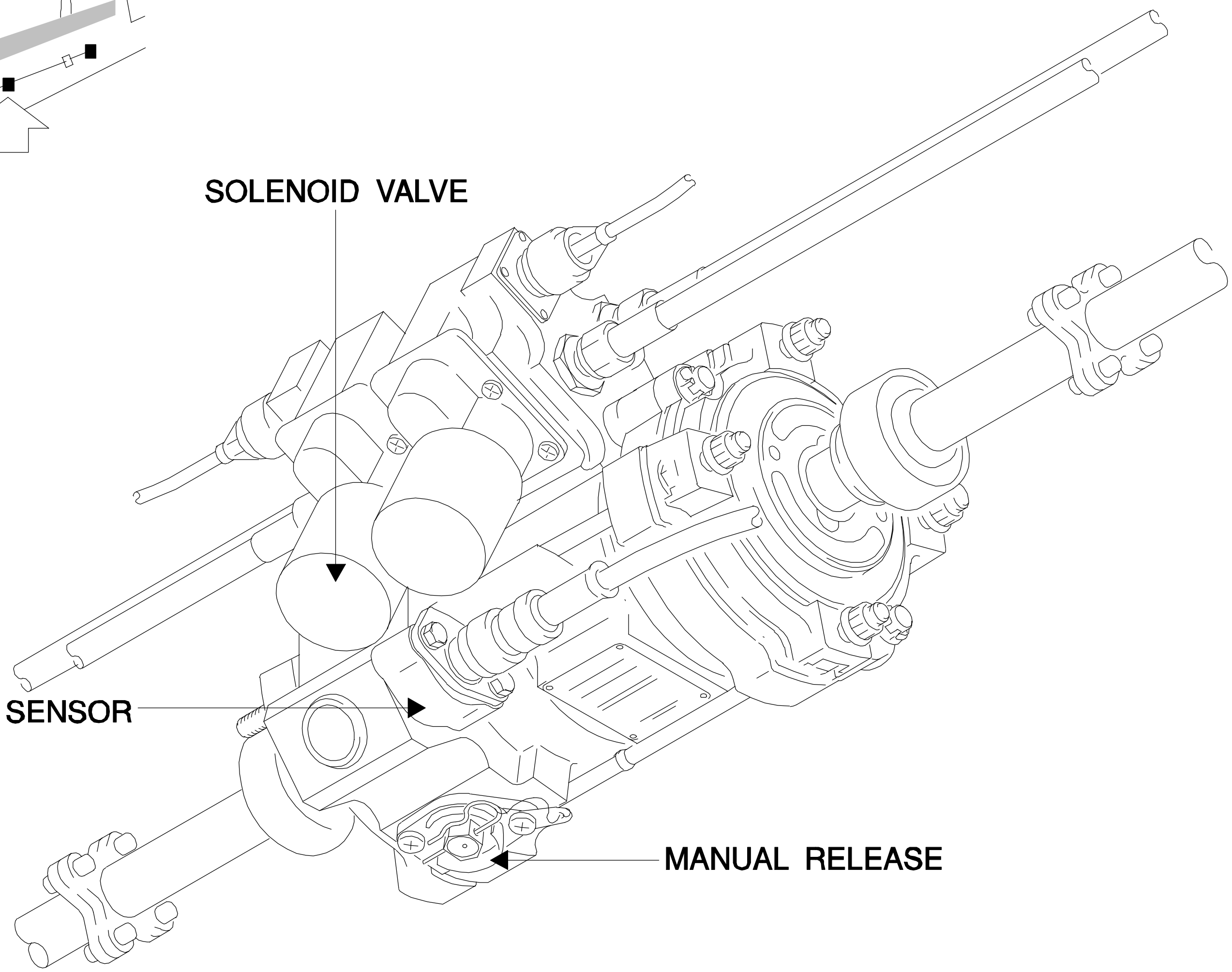
Manual release is achieved by rotating the manual release shaft in an anticlockwise direction.

- first withdraw the spring cotter pin, then rotate the release shaft until the indicator arm moves to the "M" (Maintenance) position.
At this point, the brake is off and the transmission through shaft can be rotated.
- Setting the brake to the operational position again is perfomed by rotating the release shaft clockwise, until the indicator arm is in the "O" (Operational) position.
The release shaft must be in the correct operational position, so that the spring cotter pin can be re-inserted.

REMOVAL INSTALLATION

The solenoid valves and proximity sensor are self contained LRUs.
The wing tip brakes are fully interchangeable with those fitted on the slat system.





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ASYMMETRY POSITION PICK OFF UNIT ADAPTOR

FIN : 5057CV/5135CV

ZONE : 573/673

COMPONENT DESCRIPTION

The adaptor attaches the Asymmetry Position Pick off Unit (APPU) to the flap transmission system.
It is provided with a foolproofing plate which prevents its removal when the APPU is installed.

SERVICING

To gain access to the adaptor fixing bolts, you must remove the APPU and rotate the foolproofing plate by unscrewing the plate locking screws.
Rotating the plate aligns access holes and bolt heads.

ASYMMETRY POSITION PICK OFF UNIT (APPU)

FIN : 29CV/30CV

ZONE : 573/673

COMPONENT DESCRIPTION

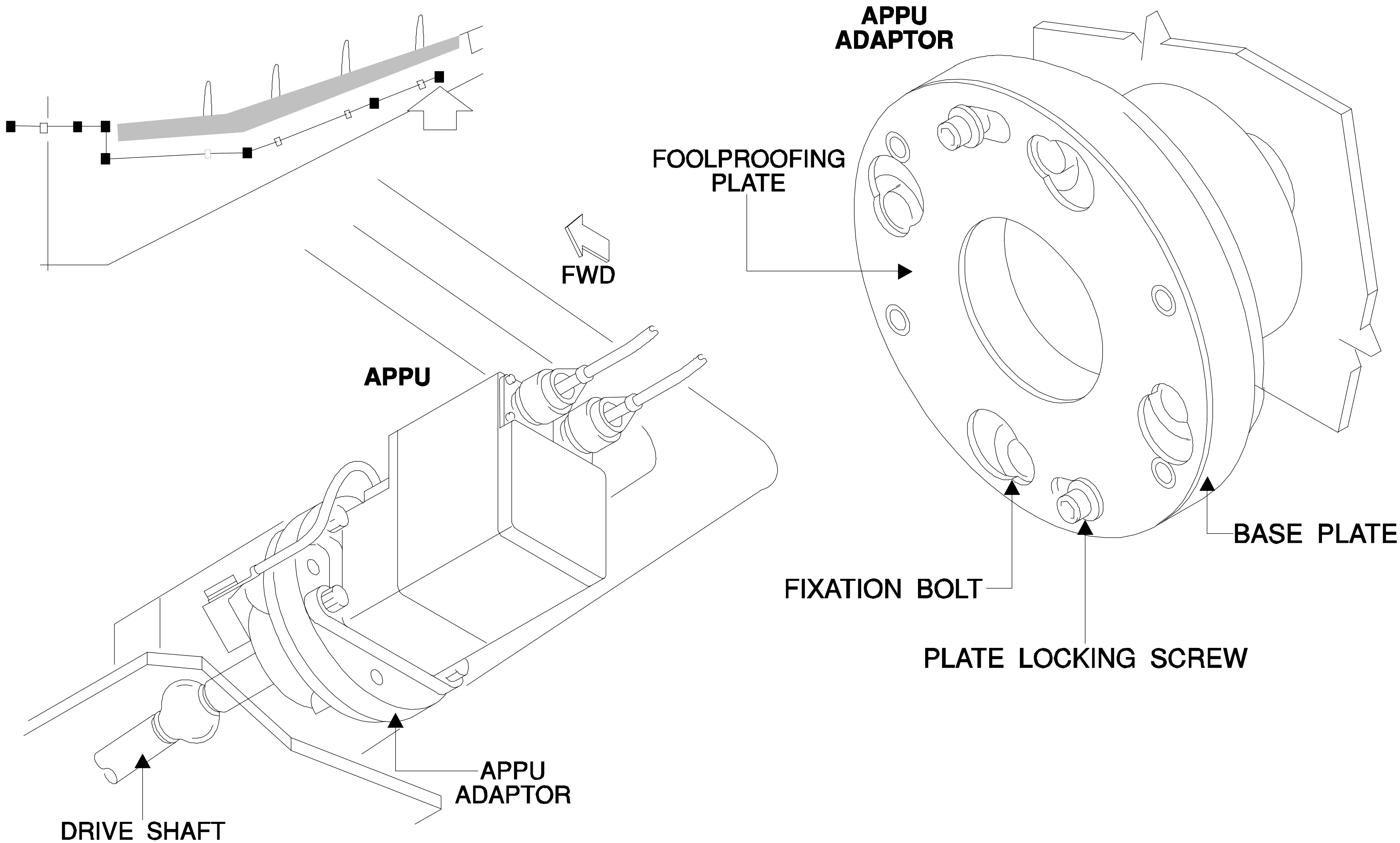
Each APPU consists of duplicated synchros driven by a single input shaft through a reduction gearing.
The electrical connector block, attached to the reduction gear housing has two connectors, each dedicated to one synchro transmitter.
The turn of the input shaft through 360 revolutions gives 360° synchro output.
For full flap travel, the angular output of each synchro is 338°.

SPECIAL DESIGN

A transparent window, located in the cover plate allows zero adjustment through a system of matching marker lines, in the casing and on the rotating shaft.

REMOVAL INSTALLATION

Each APPU is mounted on the aircraft structure via an adaptor assembly.
The APPUs are identical to and interchangeable with the Instrumentation Position Pick off Unit (IPPU) and the Feedback Position Pick off Unit (FPPU) mounted on the flap Power Control Unit (PCU).
They are also interchangeable with the PPUs installed on the slat system.
They are hermetically sealed and their internal gearing is "life lubricated".



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TORQUE SHAFTS

TORQUE SHAFT	LH FIN	ZONE	RH FIN	ZONE
0	5002CV	147	5080CV	148
1	N/A		N/A	
2	5004CV	147	5082CV	148
3	5070CV	147	5148CV	148
4	5011CV	147	5089CV	148
5	5013CV	572	5091CV	672
6	5015CV	572	5093CV	672
7	5017CV	572	5095CV	672
8	5019CV	572	5097CV	672
9	5025CV	573	5103CV	673
10	5027CV	573	5105CV	673
11	5029CV	573	5107CV	673
12	5035CV	573	5113CV	673
13	5037CV	573	5115CV	673
14	5039CV	573	5117CV	673
15	5045CV	573	5123CV	673
16	5046CV	573	5124CV	673
17	5048CV	573	5126CV	673
18	5050CV	573	5128CV	673
DRIVE SHAFT	5056CV	534	5134CV	634

COMPONENT DESCRIPTION

The torque shafts are equipped with universal or splined joints to allow angular changes of alignment

The welded end fittings have a flange for a bolted joint or splines for a sliding end connection, the male part of which, has an indicator groove for indication of minimum acceptable engagement between the male and female part.

SPECIAL DESIGN

Compliant shafts 0RH and 2RH

The compliant shafts 0RH and 2RH are machined from titanium.

Bolts connect the end fittings to the attachment flanges of the shafts.

The attachment flanges have stainless steel bushes.

The compliant shafts act as torsion dampers in the event of torque limiter lock out.

Shaft OLH

The shaft OLH consists of two shafts.

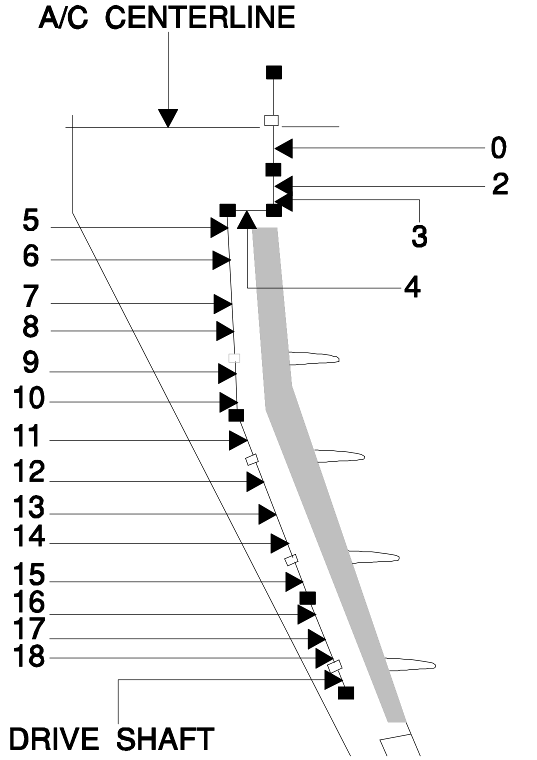
The outer shaft is machined from corrosion resistant steel to form a tube.

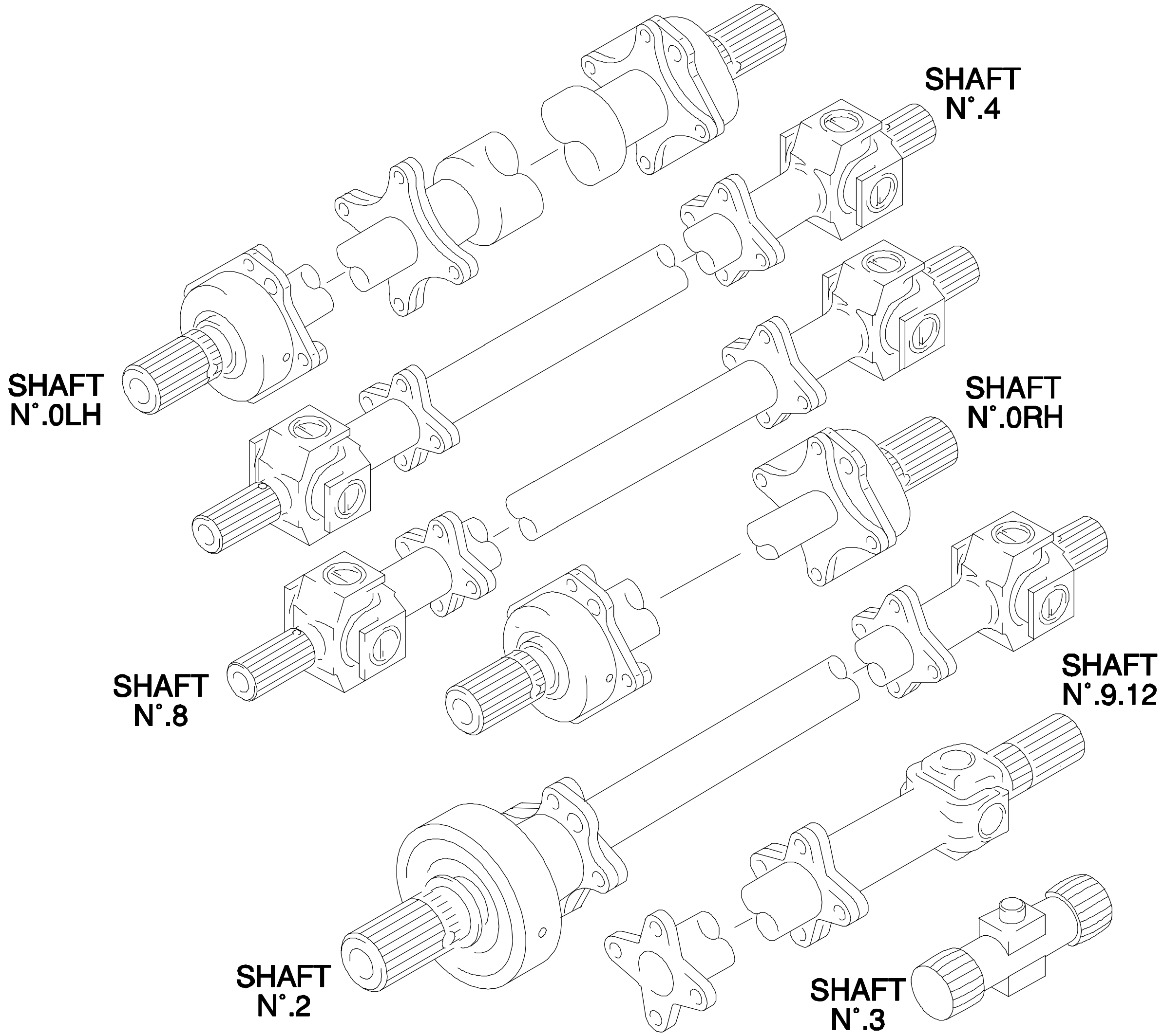
The inner shaft is a solid titanium shaft, which is wrapped in a carbon-fibre reinforced plastic (CFRP) sleeve.

The CFRP sleeve gives the shaft lateral stiffness and maintains the torsional compliance of the shaft.

Shaft 15LH and15RH

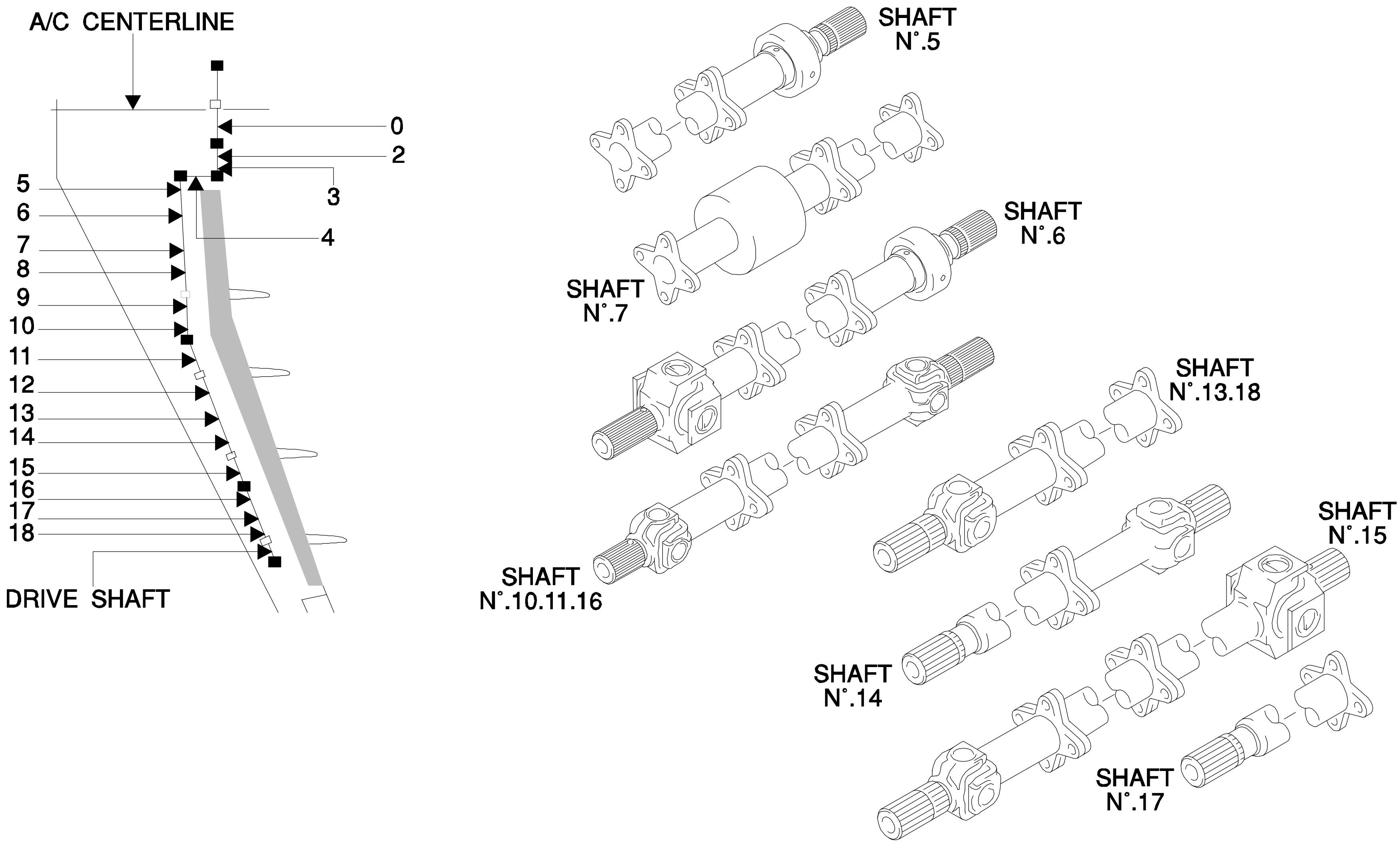
The shafts 15LH and 15RH have universal joints which are machined from a corrosion-resistant steel bar.





FQW4200 GE Metric

STUDENT NOTES



FQW4200 GE Metric

STEADY BEARINGS

LH	1	2	3	4	5	6	7	8
FIN	5014	5016	5018	5026	5036	5038	5047	5049CV
ZONE	572	572	572	573	573	573	573	573

RH	1	2	3	4	4	6	7	8
FIN	5092	5094	5096	5104	5114	5116	5125	5127CV
ZONE	672	672	672	673	673	673	673	673

COMPONENT DESCRIPTION

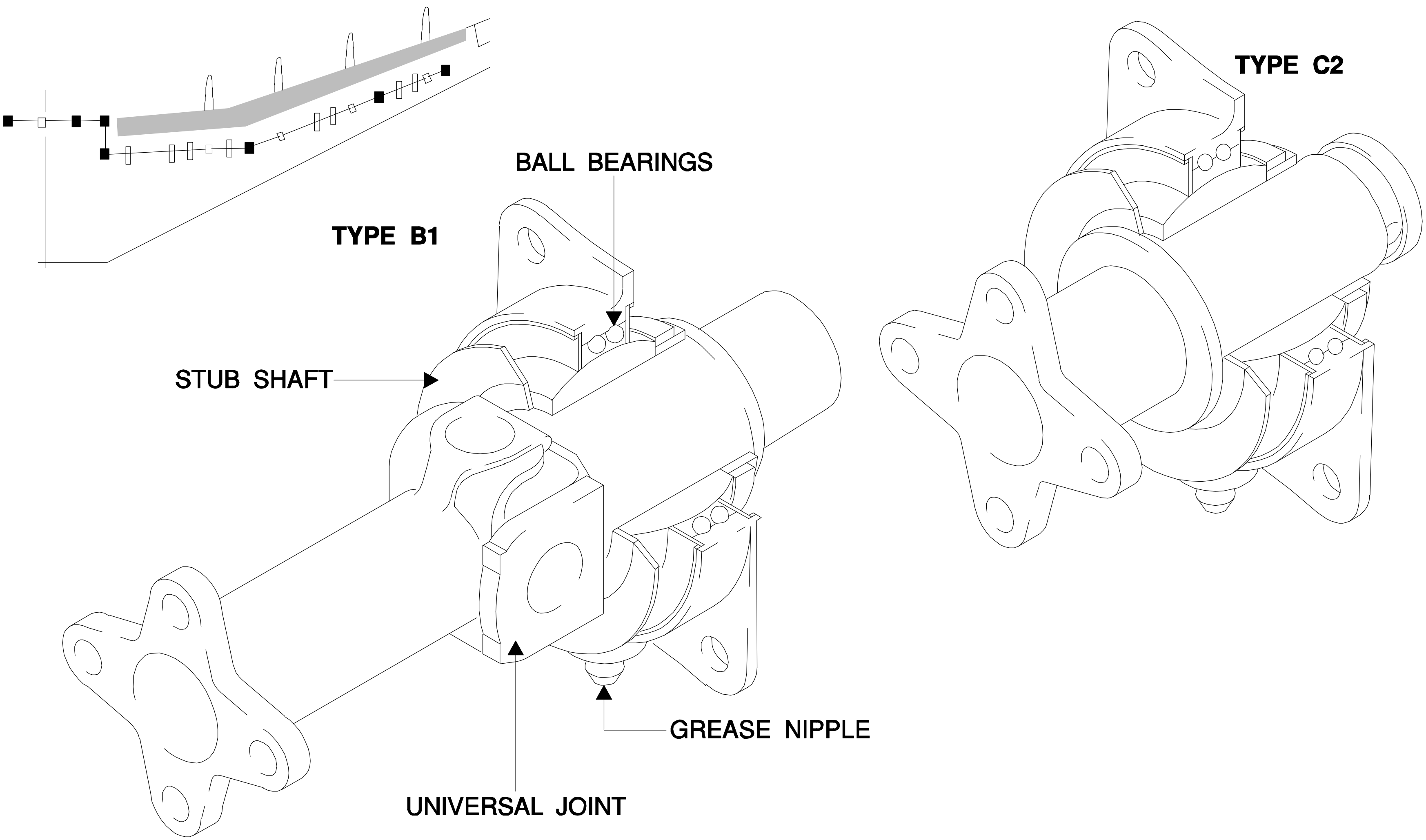
The steady bearings support the torque shafts.
Two types of bearings are used :

- types B1 and C2.

Both consist of self aligning ball bearings.

SERVICING

The self aligning ball bearings are grease lubricated and sealed.
A regreasing point is provided (nipple).



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STUDENT NOTES

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SLAT FLAP CONTROL COMPUTER EXTERNAL INTERFACES

ARINC 429 Inputs/Outputs
Discrete Inputs/Outputs

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ARINC 429 INPUTS/OUTPUTS

FCPCs and FCSCs

The flight control computers receive information about slat flap actual position for activation of the flight control laws.

CMCs

The Central Maintenance Computers (CMCs) receive the following data for maintenance, trouble shooting and tests :

- slat and flap failure info (continuously transmitted in normal mode),
- maintenance info (dialogue with the CMS interactive mode),
- LRU identification and Slat Flap Control Computer equipment code.

The CMC command word sends the ground status information to the SFCCs for the Wing Tip Brake engagement test.

ADIRUs

Each computer channel receives information about computed airspeed and corrected angle of attack from the three Air Data Inertial References Unit (ADIRUs) for slat alpha lock and flap relief function computation.

FMGECs

The Flight Management Guidance and Envelope Computers (FMGECs) receive slat flap actual position for use in flight phase computation.

DMU (OPTIONAL)

The Data Management Unit receives data from the SFCCs for condition monitoring and creation of reports.

FWCs

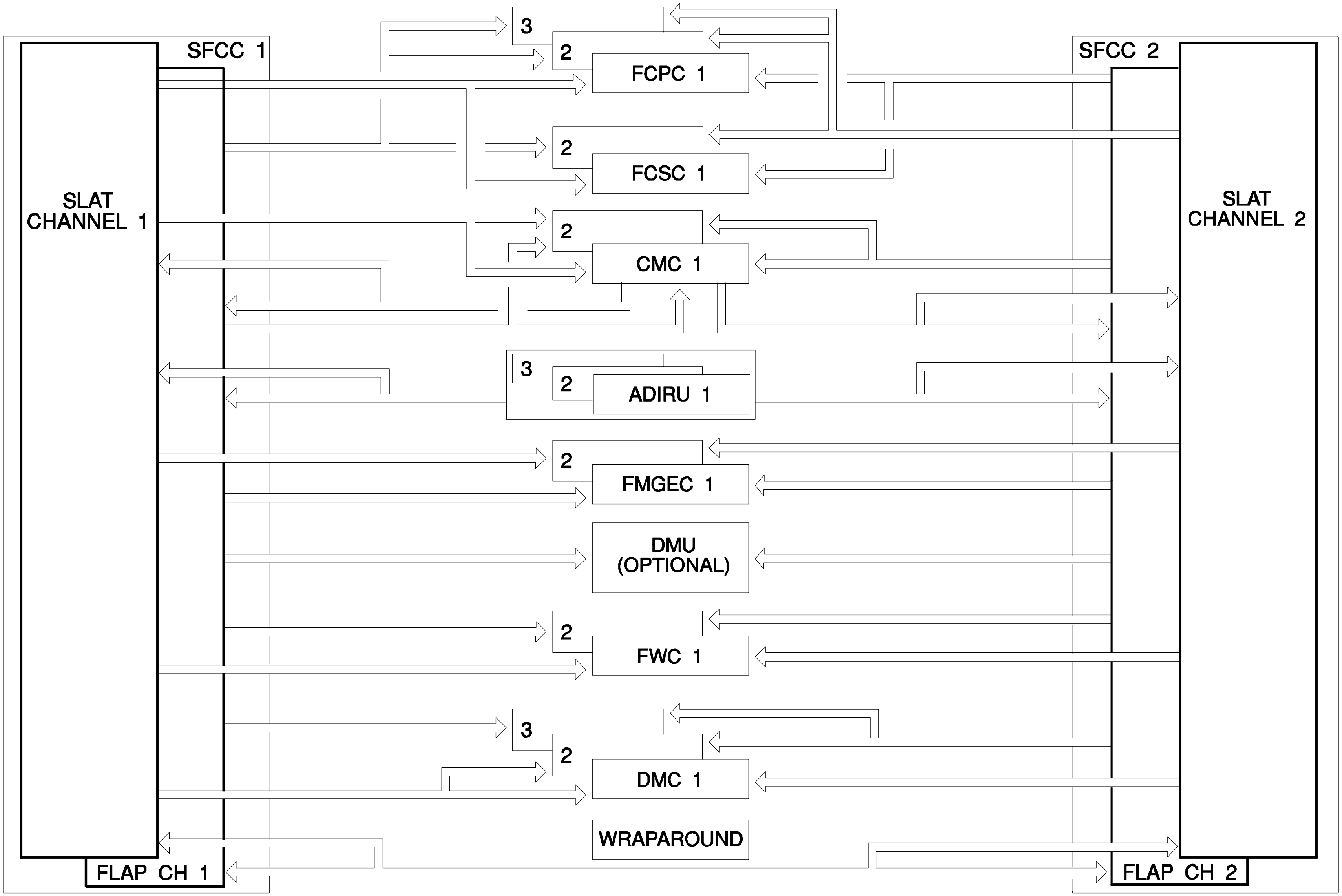
Information about position data and system status is transmitted for possible warning activation.

DMCs

Slat and flap system status and actual surface angles are transmitted for display on the Engine Warning Display Unit.

WRAPAROUND

Each SFCC is designed to receive the data transmitted to the other systems by its own ARINC 429 outputs for continuous monitoring.



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DISCRETE INPUTS/OUTPUTS

ADIRUs

The information, flaps greater or equal to 7 degrees and to 30 degrees, is used for the calculation of corrected angle of attack.
The information, flaps greater or equal to 20 degrees, is used for the correction of static pressure.

EIVMUs

Flaps greater than 12 degrees is used for computation of approach idle.

CIDS

The Cabin Intercommunication Display System (CIDS) receives slat/flap position discretes for automatic lighting of cabin passenger signs.

GPWC

The discretes sent to the Ground Proximity Warning Computer (GPWC) are used for audio warning inhibition during approach.

HSMU

Information is used for the control of the yellow hydraulic pump in case of engine failure.

FMGECs

The discretes are used as backup of the ARINC bus for speed computation.

FCMCs

"SLAT HANDLE 0" is used for fuel transfer in flight, while slat greater or equal to 16 degrees is used to empty the trim tank before landing.

FCPCs

The information, slats retracted, is used to validate the SFCC bus.

FCSCs

The discrete is used to validate the SFCC bus and to allow full deflection of the rudder via the travel limitation unit in case of failure of the two FCSCs.

SDAC

In case of system fault, level 2 warnings are displayed on the ECAM, through the System Data Acquisition Concentrators (SDACs).

LGCIUs

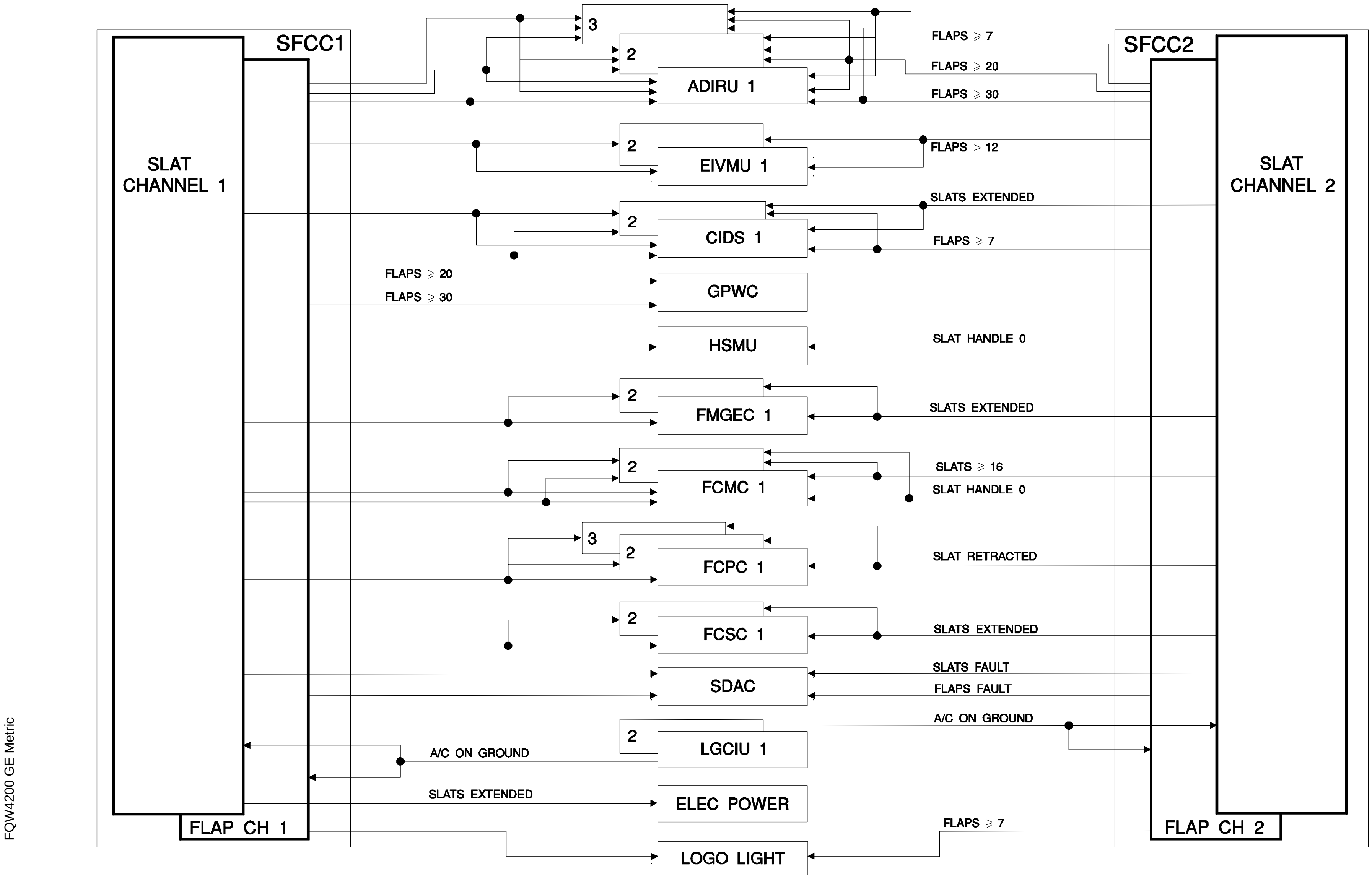
With aircraft on ground condition valid, the manual reset of the wing tip brakes is possible.

ELEC POWER

With Ram Air Turbine (RAT) extended, the discrete allows power supply from batteries in approach configuration, via electrical power relays.

LOGO LIGHTS

The discrete, flaps greater or equal to 7 degrees, is used to switch on the logo lights via relays.


SFCC1
SLAT CHANNEL 1
FLAP CH 1
SFCC2
SLAT CHANNEL 2
FLAP CH 2
ADIRU 1
FLAPS ≥ 7
FLAPS ≥ 20
FLAPS ≥ 30
EIVMU 1
FLAPS > 12
CIDS 1
SLATS EXTENDED
FLAPS ≥ 7
GPWC
FLAPS ≥ 20
FLAPS ≥ 30
HSMU
SLAT HANDLE 0
FMGEC 1
SLATS EXTENDED
FCMC 1
SLATS ≥ 16
SLAT HANDLE 0
FCPC 1
SLAT RETRACTED
FCSC 1
SLATS EXTENDED
SDAC
SLATS FAULT
FLAPS FAULT
LGCIU 1
A/C ON GROUND
A/C ON GROUND
ELEC POWER
SLATS EXTENDED
LOGO LIGHT
FLAPS ≥ 7
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STUDENT NOTES

SLAT FLAP CONTROL COMPUTER INTERNAL INTERFACES

Command Sensor Unit (CSU)
Power Control Unit (PCU)
Position Pick-off Units (PPUs)
Wing Tip Brakes (WTBs)
Flap Sensors
SFCC Cross-Links (X-Links)
PIN Programming

This item deals with the Slap Flap Control Computer (SFCC) internal interfaces, that is to say, data sent to and received from the slat flap system components.
Slat and flap internal interfaces are identical apart from the interconnecting strut and track 4 sensors which are not installed on the slat system. In this part, only flap interfaces will be shown

COMMAND SENSOR UNIT

The Command Sensor Unit sends two sets of discrete signals to each flap channel (one signal for each lane), for a new slat flap selection demand.

POWER CONTROL UNIT

Discrete outputs from the Slat Flap Control Computers (SFCCs) are sent to the Power Control Unit for the control of the valve block solenoid valves.

The pressure switch of each valve block sends a discrete signal to its related SFCC for the monitoring of hydraulic pressure in the valve block.

POSITION PICK-OFF UNITS

The FPPU and the APPUs each include two synchros, one connected to SFCC1, the other one to SFCC2.

Each synchro sends an analog signal to its related computer channel for failure detection and system monitoring.
Each synchro receives a power excitation signal from its associated SFCC.

WING TIP BRAKES

Each Wing tip brake solenoid valve receives a discrete signal from its related SFCC for the control of the wing tip brake.

One proximity switch on each wing tip brake sends analog proximity signals to its related SFCC for the brake engagement test.

FLAP SENSORS

Each interconnecting strut sensor sends a disconnect signal to its related SFCC in case of a disconnect in drive station 1, 2 or 3.

Each flap track 4 sensor sends a disconnect signal to its dedicated SFCC in case of a disconnect in drive station 4 or 5.

SFCC CROSS LINKS

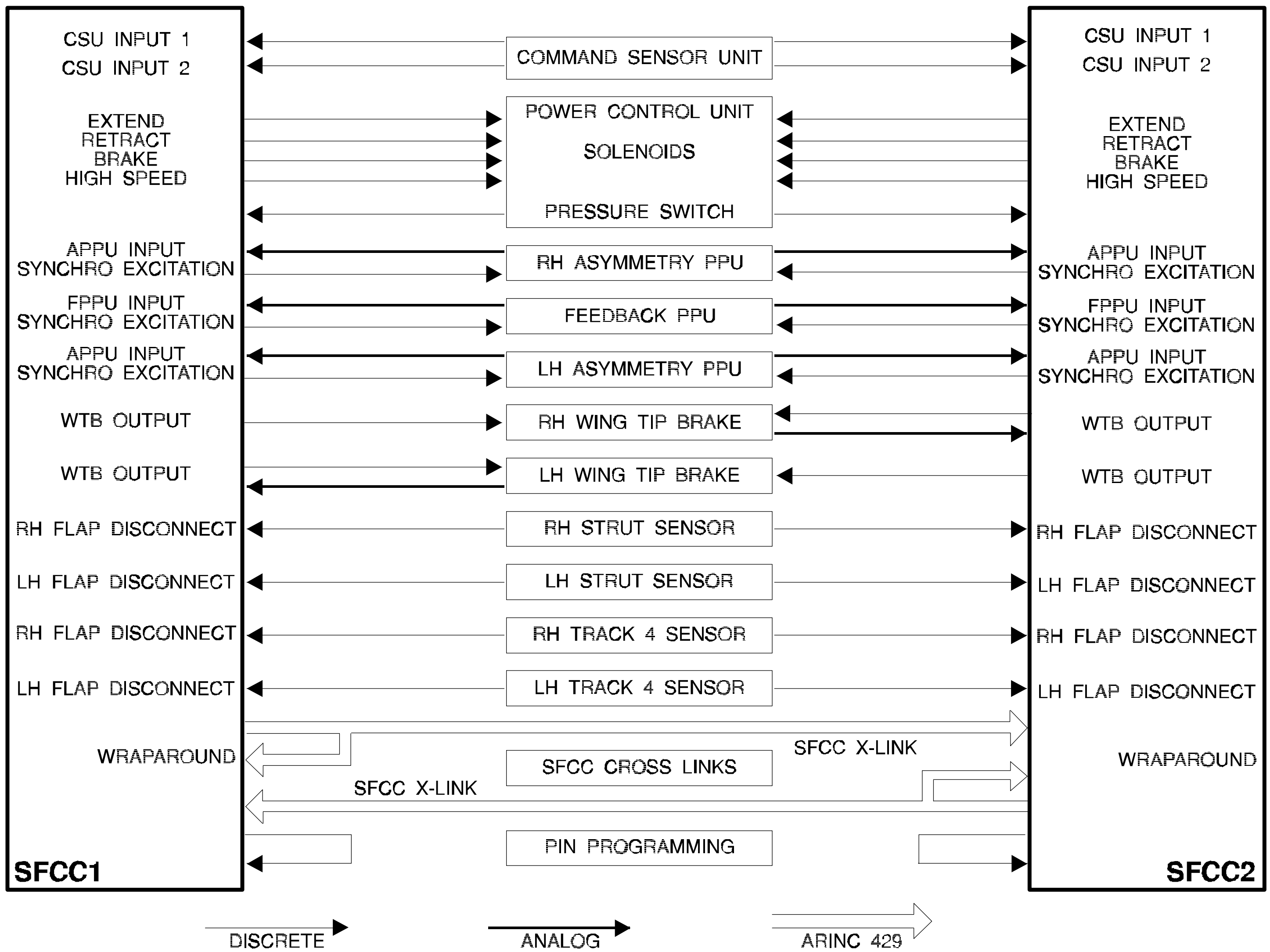
Each computer accepts data inputs from the other computer through a cross talk data link and monitors its ARINC 429 outputs by feeding the output data into feedback inputs.

In addition, each channel receives and accepts data from the other channel in the same SFCC in order to enable the transmission of slat flap data by each channel.

PIN PROGRAMMING

Each computer has an installation and an operation mode coding input. With installation coding input, each SFCC accepts two discrete coding signals enabling it to distinguish whether it is installed in position 1 or 2.

With operation mode coding input, each SFCC accepts discrete coding signals enabling it to distinguish between different operation modes (slat and/or flap load relief enabled or disabled).



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STUDENT NOTES

SLAT / FLAP PPU ZEROING

Preparation
Adjustment

This item gives information about manual adjustment of the Position Pick-off Units (PPUs).
All the Position Pick-off Units fitted on the aircraft (two Feedback, two Instrumentation and four Asymmetry) are the same and interchangeable.

SAFETY PRECAUTIONS

WARNING : PUT THE SAFETY DEVICES AND THE WARNING NOTICE IN POSITION BEFORE YOU START A TASK ON OR NEAR :

- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND ASSOCIATED DOORS
- COMPONENTS THAT MOVE.

CAUTION : MAKE SURE THAT THE MAINTENANCE DEVICES OF THE WING TIP BRAKES ARE IN THE "O" (OPERATION) POSITION, TO PREVENT MOVEMENT OF THE TRANSMISSION SYSTEM DURING MAINTENANCE.

STUDENT NOTE

PREPARATION

Before adjustment, the PPU must be removed.
Do not remove the Feedback or Instrumentation PPU when the Pressure Off Brakes are removed from the Power Control Unit.
When the PPU is removed :

- unlock the locking plate of the PPU drive shaft, by pressing the plate in;
- make sure that the drive shaft turns freely.

ADJUSTMENT

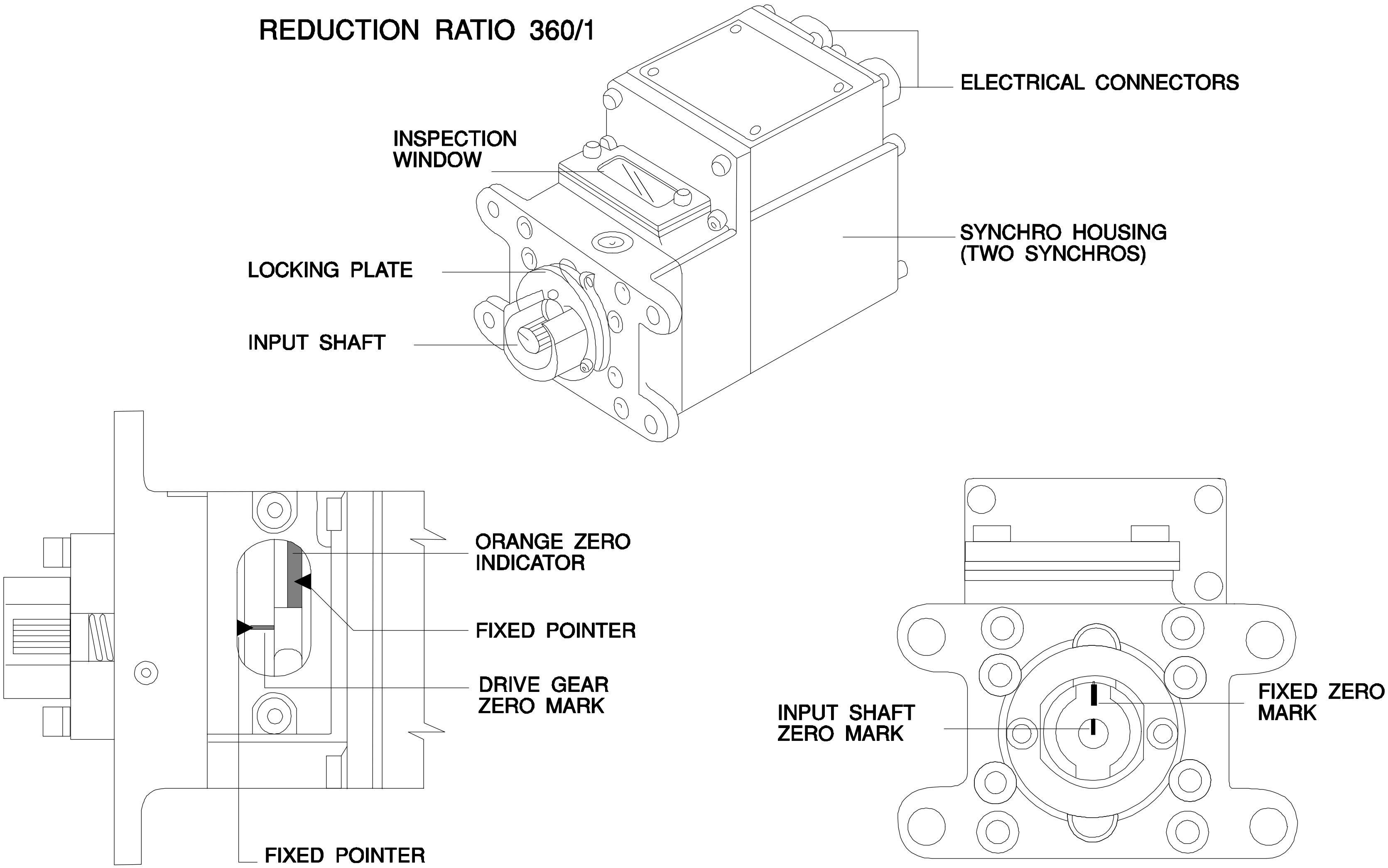
To perform zeroing, fulfill the following procedure :

- turn the input shaft, align the orange zero indicator with the fixed pointer and align the drive gear zero mark with the fixed pointer;
- make sure that the input shaft zero mark and the fixed zero mark are aligned.

Note that the mechanical zero position and the electrical zero position are the same.

If the PPU is not to be immediately installed :

- install a tie-wrap behind the locking plate;
- attach a label to the PPU to tell persons that it is locked in the zero position.



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STUDENT NOTES

CMS SPECIFIC PAGE PRESENTATION

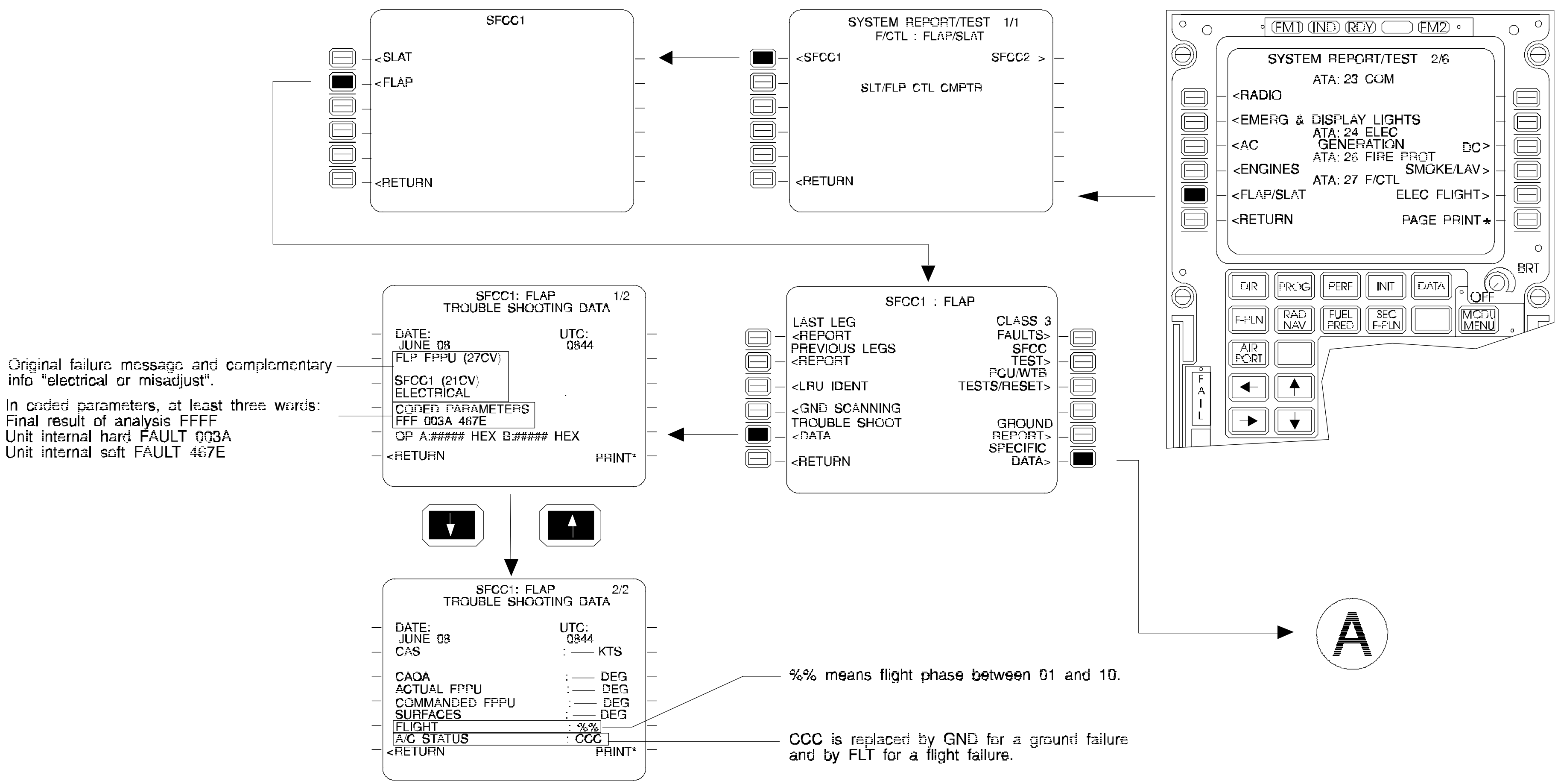
General
Trouble Shooting Data
Specific Data
PCU/WTB Tests/Reset

GENERAL

Selecting FLAP/SLAT from the SYSTEM REPORT/TEST enables access to SFCC 1 and SFCC2 main menus.
Selecting SFCC1 enables access to the SLAT and FLAP main menus.
FLAP menu includes a TROUBLE SHOOTING DATA key and a SPECIFIC DATA key.

TROUBLE SHOOTING DATA

When the TROUBLE SHOOTING DATA key is pressed, the screen shows the date and time when the failure occured, the failure message and the related coded parameters.
The second page gives the Computed Airspeed, the Calculated Angle of Attack, the actual and the commanded FPPU angles, the surface deflection, the flight phase and the status of the aircraft.
Each failure is shown over two pages.
If no failure is detected, the " NO FAULTS DETECTED " legend is displayed.


SFCC1
<SLAT
<FLAP
<RETURN
SYSTEM REPORT/TEST 1/1
F/CTL : FLAP/SLAT
<SFCC1
SFCC2 >
SLT/FLP CTL CMPTR
<RETURN
SYSTEM REPORT/TEST 2/6
ATA: 23 COM
<RADIO
<EMERG & DISPLAY LIGHTS
ATA: 24 ELEC
<AC
GENERATION
DC>
ATA: 26 FIRE PROT
<ENGINES
SMOKE/LAV>
ATA: 27 F/CTL
<FLAP/SLAT
ELEC FLIGHT>
<RETURN
PAGE PRINT *
FM1 IND RDY FM2
BRT
OFF
DIR PROG PERF INIT DATA
F-PLN RAD NAV FUEL PRED SEC F-PLN MCDU MENU
AIR PORT
FAIL
SFCC1: FLAP 1/2
TROUBLE SHOOTING DATA
DATE:
JUNE 08
UTC:
0844
FLP FPPU (27CV)
SFCC1 (21CV)
ELECTRICAL
CODED PARAMETERS
FFF 003A 467E
OP A:##### HEX B:##### HEX
<RETURN
PRINT*
Original failure message and complementary info "electrical or misadjust".
In coded parameters, at least three words:
Final result of analysis FFFF
Unit internal hard FAULT 003A
Unit internal soft FAULT 467E
SFCC1 : FLAP
LAST LEG
<REPORT
CLASS 3
FAULTS>
PREVIOUS LEGS
<REPORT
SFCC
TEST>
<LRU IDENT
PCU/WTB
TESTS/RESET>
<GND SCANNING
TROUBLE SHOOT
<DATA
GROUND
REPORT>
SPECIFIC
DATA>
<RETURN
A
SFCC1: FLAP 2/2
TROUBLE SHOOTING DATA
DATE:
JUNE 08
UTC:
0844
CAS : —— KTS
CAOA : —— DEG
ACTUAL FPPU : —— DEG
COMMANDED FPPU : —— DEG
SURFACES : —— DEG
FLIGHT : %%
A/C STATUS : CCC
<RETURN
PRINT*
%% means flight phase between 01 and 10.
CCC is replaced by GND for a ground failure and by FLT for a flight failure.

SPECIFIC DATA

PPU
The PPU specific data page shows the PPU legend.
This page is transmitted again every 5 seconds with updated data.

DISCRETE INPUTS
The discrete input data is updated every five seconds.

SGOI : SYSTEM GROUND OPERATION INHIBIT : "%"
Each SFCC accepts two discrete signals to inhibit flap movement when the aircraft is on ground.
" % " is replaced by "active" or inactive.

PIN PROGRAMMING :
Each SFCC accepts two discrete signals enabling it to distinguish between different operation modes that are aircraft versions (flap relief enabled / disabled, flap auto-setting....).
The STATUS values are replaced by "1" or "0".

LEVER POSITION :
" ----" is replaced by 0,1,2,3 or FULL.

INST . CODE : INSTALLATION CODING INPUT : "P"
Each SFCC accepts 2 discrete coding signals which enable it to distinguish whether it is installed in position 1 or 2.
"P" is replaced by "1" or "2".

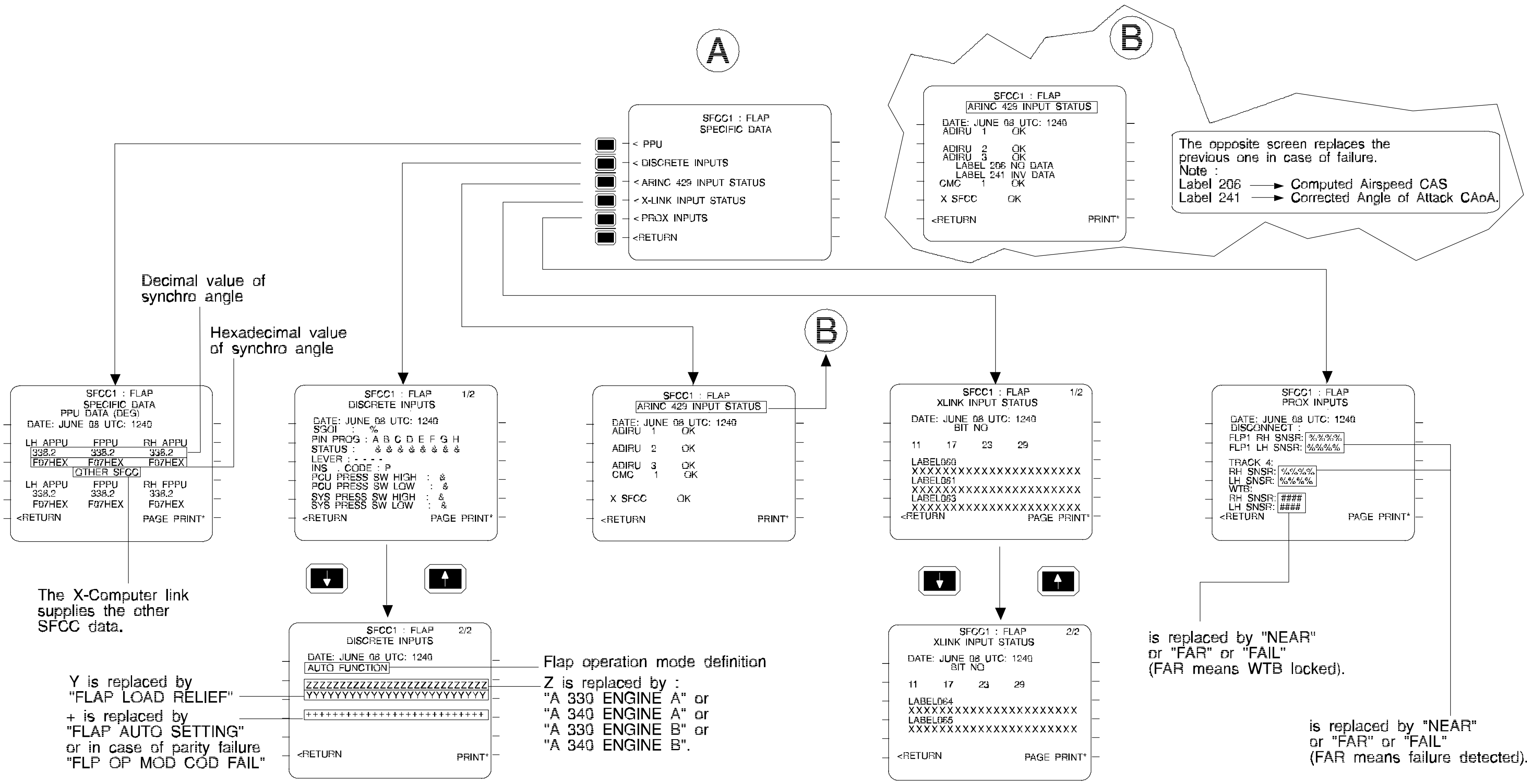
PCU PRESS SW : "&"
Each SFCC channel has 2 discrete signal inputs to receive the High and Low pressure signals from the pressure switch mounted on the PCU valve block.
" & " is replaced by "1" or "0".

SYS PRESS SW : "&"
Each SFCC channel has 2 discrete signal inputs to receive the Low pressure signals from its associated hydraulic power supply.
These inputs are used for PCU valve monitoring and WTB engagement test.
" & " is replaced by "1" or "0".

AUTO FUNCTION
This data shows only the coding pattern for the aircraft version in which the SFCC is installed.

ARINC 429 INPUT STATUS
Each SFCC is designed to receive and accept data from the three ADIRUs for use in slat alpha-lock and flap relief function computation.
Each SFCC channel receives this data from the ADIRUs in low speed ARINC 429 format.

X-LINK INPUT STATUS
The status information is continuously transmitted by ARINC 429 words.
The update rate of the X-Computer data is 100ms, except for PPU data words which must be updated at least every 1 second.
The last page shows details about information contained in LABEL 60.



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X-LINK INPUT STATUS (following)
Here are the contents of label 60.
Failure bits are set to "1" if the Fault is present
Flap WTB latched bit is set if own WTB is commanded for Software-Latch (SW) and/or Hardware-Latch (HW).
Fault bit is set to "1" if any a.m. failure exists (bit 11 - bit 17).

PROX INPUTS
The SFCC are provided with inputs for interfacing with the proximity sensors mounted on flap track 4, on flap interconnecting struts and on the wing tip brakes.
This page is transmitted again every five seconds with updated data.

BIT NO.	FUNCTION	BIT STATUS
1	I	X
2	I	X
3	I	X
4	I	X
5	I	X
6	I Flap X-computer	X
7	I Status Information	X
8	I	X
9	SDI	X
10	SDI	X
11	Asymmetry	1
12	Runaway	1
13	Overspeed	1
14	Computer Fault	1
15	Uncommanded Movement	1
16	Synchro Excitation Fault	1
17	PPU-wiring Fault	1
18	Spare	0
19	Flap WTB solenoid Fault	1
20	Flap Disconnect	1
21	Flap Track 4 Fault	1
22	CSU Disadjust Fault	1
23	Low Hydraulic Pressure	1
24	Spare	0
25	High Speed Commanded	1
26	Flap WTB Latched	1
27	Spare	0
28	Spare	0
29	Fault	1
30	SSM	X
31	SSM	X
32	Parity	X

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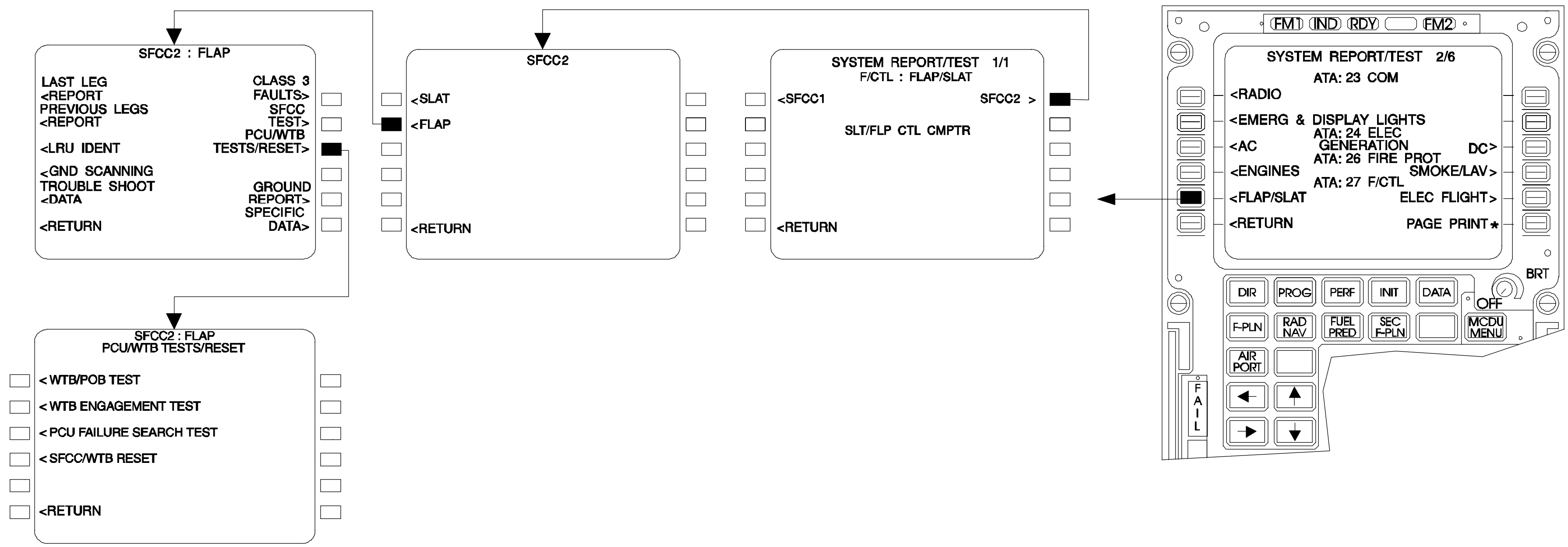
PCU/WTB TESTS/RESET

When you pushed the line key adjacent to the PCU/WTB TESTS/RESET, you access to several dynamic tests in interactive mode:

- WTB/POB TEST
- WTB ENGAGEMENT TEST
- PCU FAILURE SEARCH TEST
- SFCC/WTB RESET

The WTB ENGAGEMENT TEST legend has the < prompt only when you do the test from the SFCC system 2.



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WTB/POB TEST

This test checks the performance of the WTBs and PCU POBs.

The job set-up information you need to prepare the system for the test is displayed on the MCDU.

When the initial conditions are met and you push the line key adjacent to CONFIRM START OF TEST, the SFCC starts the WTB/POB test.

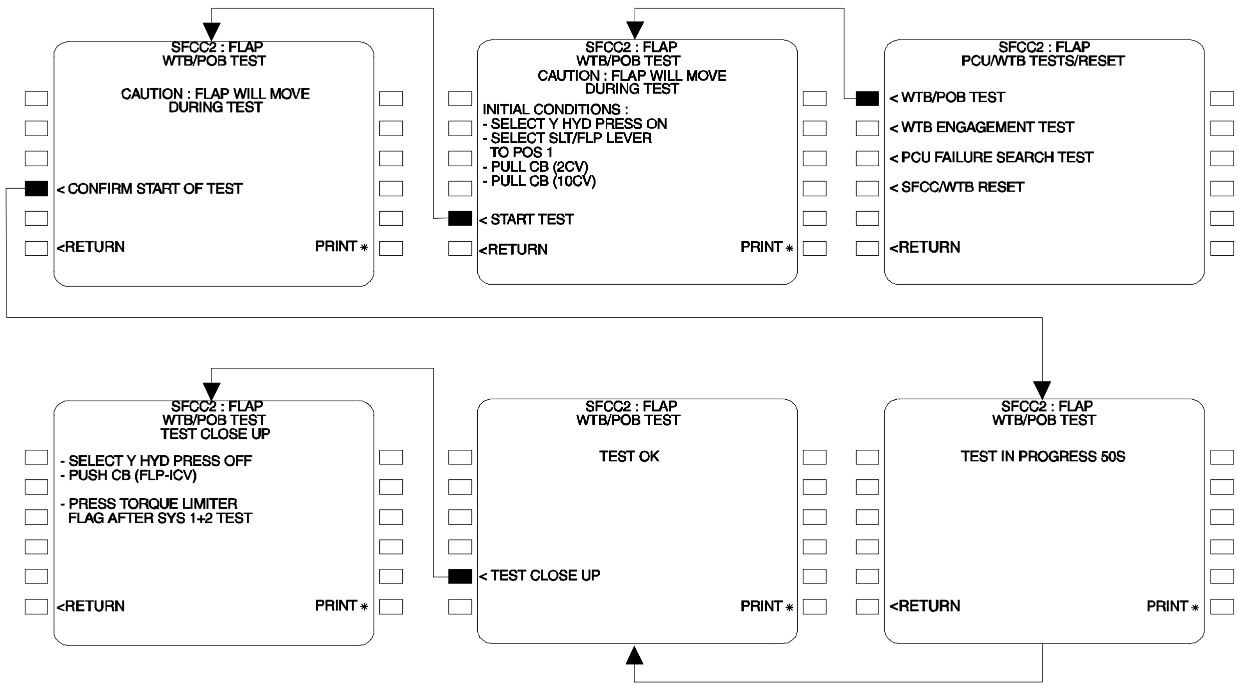
The test consists in monitoring the difference angle between the APPU and the FPPU during the operation of the flap transmission.
The transmission is operated in extension and retraction while a torque is applied to the WTBs and PCU POBs according to a specific sequence .

If the monitored angles are correct, the test is OK.

If the system completes the test but there is a failure in the system, the screen shows:

- the ATA reference number of the failure
- the failed LRU
- the class of the failure
- the TEST CLOSE UP legend

At the end of the test, you must check the torque limiter flags and reset them if necessary.



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WTB ENGAGEMENT TEST

The SFCC 2 automatically starts daily the flap WTB engagement test during the flight phase 9 (after landing).
If the WTB engagement test was not done or unsuccessful for 10 consecutive days the fault message "FLAP TIP BRK FAULT" is displayed on the E/WD.

This test can also be initiated manually from the MCDU using the SFCC2 channel.

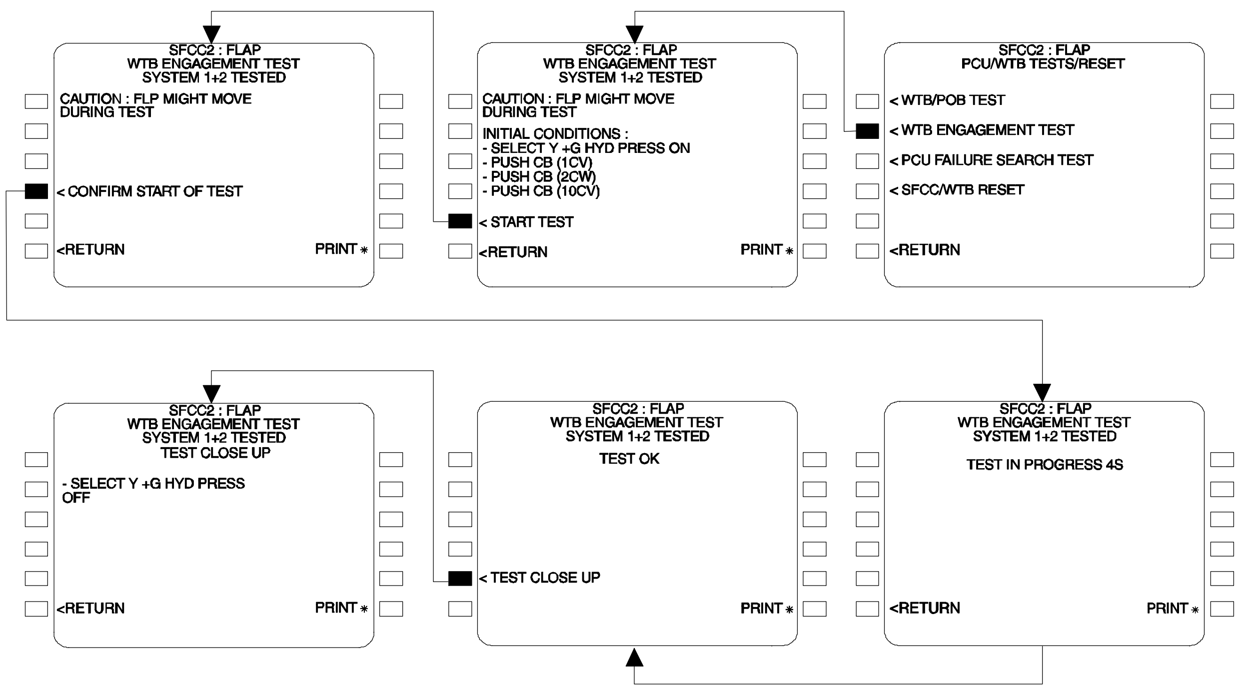
The job set-up information you need to prepare the system for the test are displayed on the MCDU.

When the initial conditions are met and you push the line key adjacent to CONFIRM START OF TEST, the SFCC starts the test.

The test consists in energizing and de-energizing the WTB solenoid valves and checking the brake application from the proximity sensors.

If the WTB proximity status is correct, then the WTB engagement test is OK.

If the system completes the test but there is a failure in the system, the screen shows:
- the ATA reference number of the failure
- the failed LRU
- the class of the failure
- the TEST CLOSE UP legend



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PCU FAILURE SEARCH TEST

If the system has found a PCU failure during flight or on the ground you can do a PCU failure search through the MCDU.

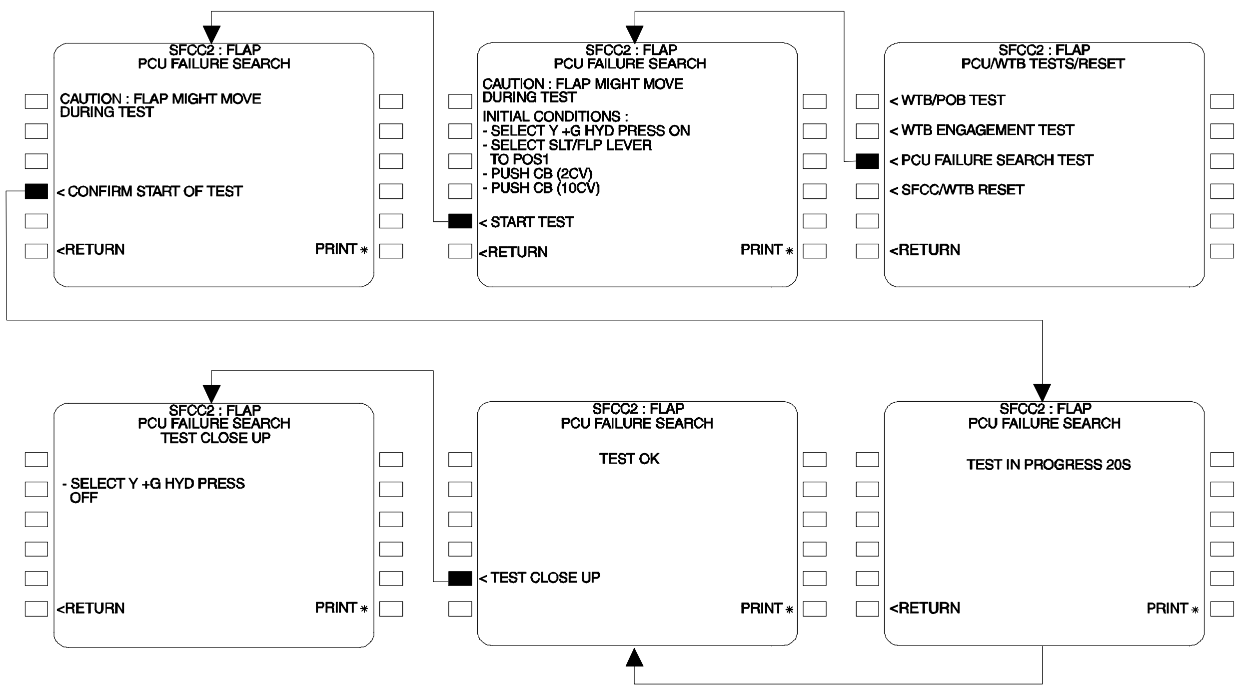
The job set-up information you need to prepare the system for the test is displayed on the MCDU.

When the initial conditions are met and you push the line key adjacent to CONFIRM START OF TEST, the SFCC starts the test.

The test consists in monitoring the PCU pressure switch status while the extension, retraction and POB solenoid valves are energized and de-energized.

If the PCU pressure switch indicates high pressure while the solenoid valves are energized, the PCU failure search test is successful. The message TEST OK is displayed with the TEST CLOSE UP legend.

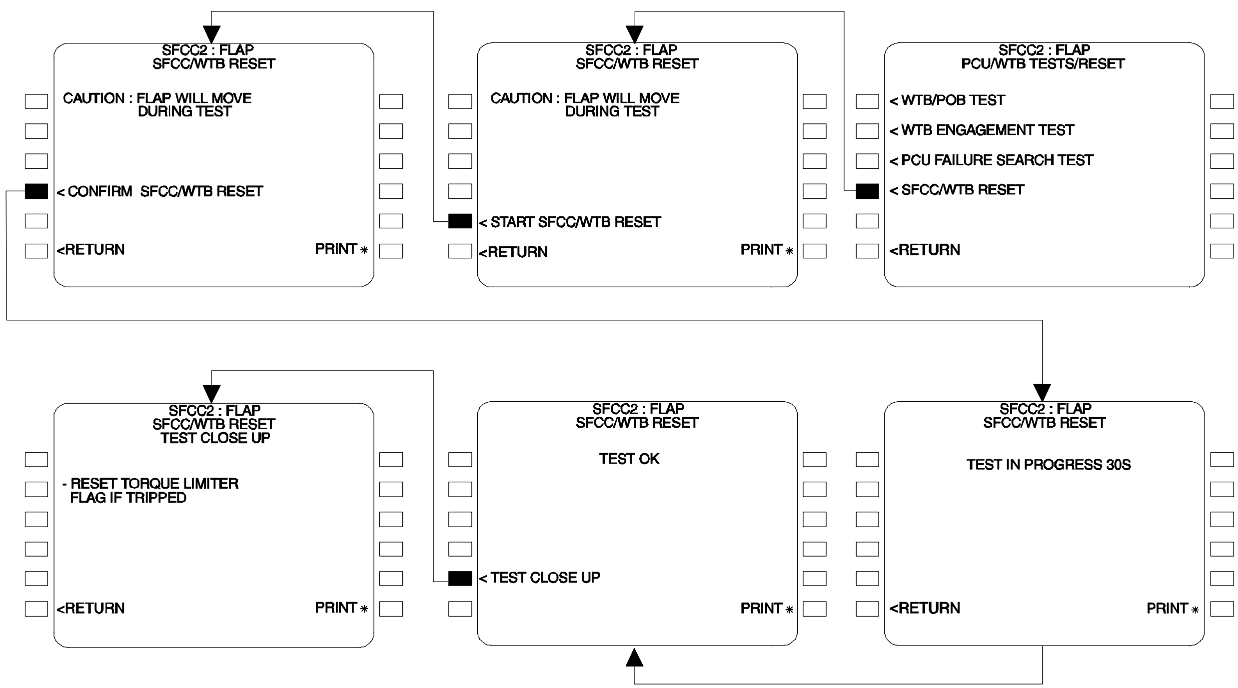
If the PCU pressure switch indicates low pressure while the solenoid valves are energized, the SFCC:
- stops the PCU failure search test
- performs an abnormal shutdown of the related valve block
- sends the related failure data to the MCDU


SFCC2 : FLAP
PCU FAILURE SEARCH
CAUTION : FLAP MIGHT MOVE DURING TEST
< CONFIRM START OF TEST
<RETURN
PRINT *
SFCC2 : FLAP
PCU FAILURE SEARCH
CAUTION : FLAP MIGHT MOVE DURING TEST
INITIAL CONDITIONS :
- SELECT Y +G HYD PRESS ON
- SELECT SLT/FLP LEVER TO POS1
- PUSH CB (2CV)
- PUSH CB (10CV)
< START TEST
<RETURN
PRINT *
SFCC2 : FLAP
PCU/WTB TESTS/RESET
< WTB/POB TEST
< WTB ENGAGEMENT TEST
< PCU FAILURE SEARCH TEST
< SFCC/WTB RESET
<RETURN
SFCC2 : FLAP
PCU FAILURE SEARCH
TEST CLOSE UP
- SELECT Y +G HYD PRESS OFF
<RETURN
PRINT *
SFCC2 : FLAP
PCU FAILURE SEARCH
TEST OK
< TEST CLOSE UP
PRINT *
SFCC2 : FLAP
PCU FAILURE SEARCH
TEST IN PROGRESS 20S
<RETURN
PRINT *

SFCC/WTB RESET

This test enables you to reset the WTB once applied.

At the end of the test, you must check the torque limiter flags and reset them if necessary.



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FLIGHT CONTROLS SERVICING

THS Actuator Servicing
Flap and Slat PCU Servicing
Flap Actuator Servicing

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WARNING : MAKE SURE THAT THE SAFETY DEVICES AND THE WARNING NOTICES ARE IN POSITION BEFORE YOU START A TASK ON OR NEAR :
- THE FLIGHT CONTROLS
- THE FLIGHT CONTROL SURFACES
- THE LANDING GEAR AND THE RELATED DOORS
- COMPONENTS THAT MOVE.

MOVEMENT OF COMPONENTS CAN KILL OR INJURE PERSONS.

STUDENT NOTES

THS ACTUATOR SERVICING

OIL REPLENISHING OF THE THS ACTUATOR

Material No. 03-003 USA MIL-L-7808
TURBINE SYNTHETIC BASE LUBRICATING OIL

(1) Remove the cap (1) from the oil fill plug (2).

(2) Install the THS ACTUATOR OIL FILLING TOOL on the oil fill plug (2).

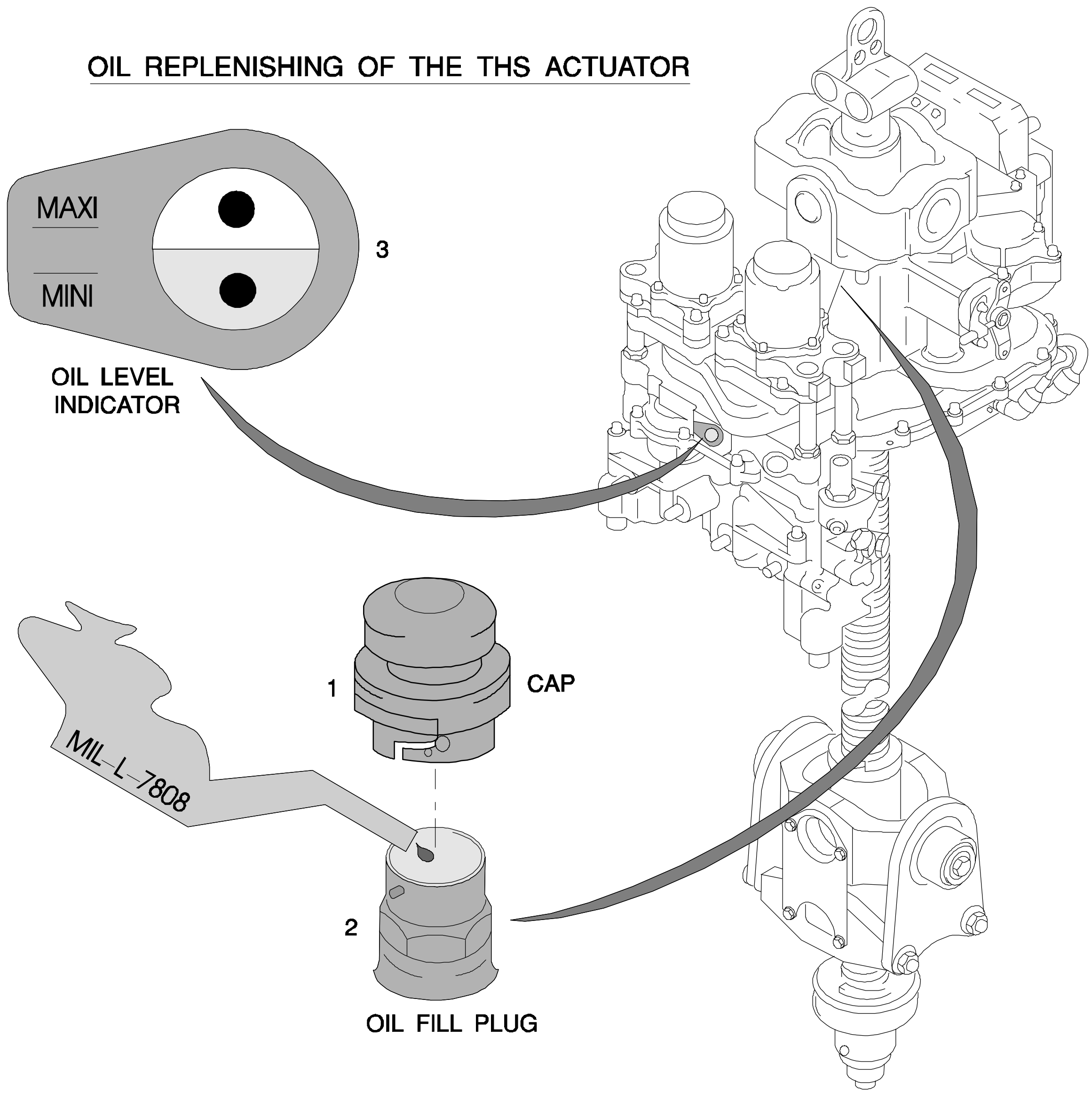
(3) Monitor the oil quantity indicator (3) and fill the THS actuator with oil, until the quantity is correct.
The correct quantity is reached when the oil level is in the middle position between the MINI and MAXI marks.

(4) Remove the THS ACTUATOR OIL FILLING TOOL.

(5) Install the cap (1).

NOTE : The simplified procedure is described here, refer to the AMM for the detailed procedure.

OIL REPLENISHING OF THE THS ACTUATOR



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FLAP AND SLAT PCU SERVICING

TOP UP THE FLAP POWER CONTROL UNIT (PCU) GEARBOX TO CONFIRM THE FLUID LEVEL

Material No. 03-003 USA MIL-L-7808
TURBINE SYNTHETIC BASE LUBRICATING OIL

(1) Remove the oil fill plug (1).

(2) Remove and discard the preformed packing (2).

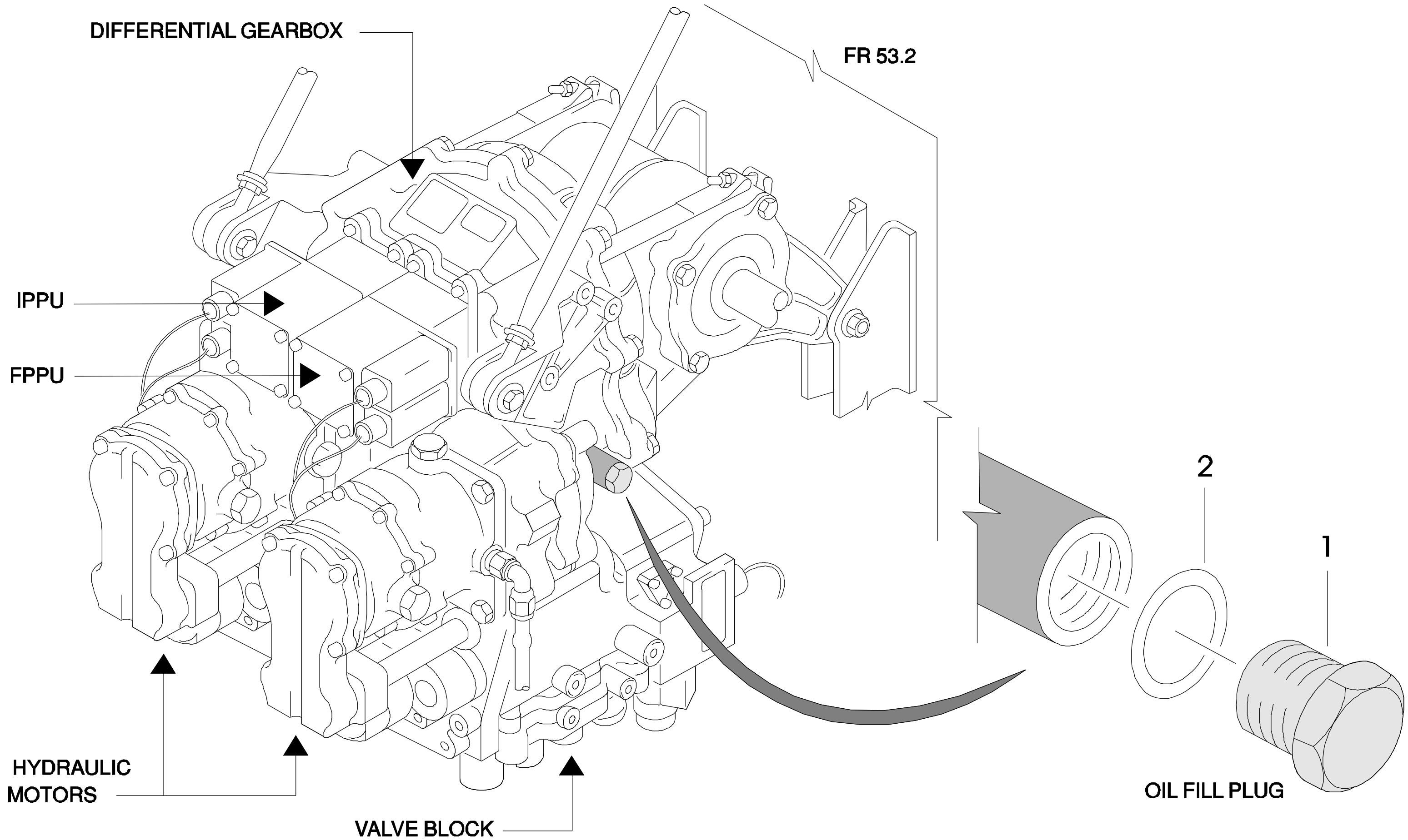
(3) Slowly add oil to the flap PCU gearbox until it comes out of the oil-fill-hole.

(4) Apply oil to the new preformed packing (2).

(5) Install the new oil fill plug (1) with the new packing (2) and torque the plug (1) following the AMM procedure.

NOTE : Slat PCU servicing uses the same procedure.
The simplified procedure is described here, refer to the AMM for the detailed procedure.

TOP UP THE FLAP PCU GEARBOX TO CONFIRM THE FLUID LEVEL



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FLAP ACTUATOR SERVICING

Make sure that the flaps are retracted.
Extend flaps to position 2.

DRAIN, REFILL AND FLUSH THE ACTUATOR TO CONFIRM THE FLUID LEVEL

Material No. 06-001 USA MIL-L-23398
AIR DRYING SOLID FILM LUBRICANT

(1) Remove the oil fill plugs (1) and discard the 0-rings (2).

(2) Install the new 0-rings (2) to the plugs (1).

(3) Apply lubricant material to the plugs (1).

(4) When the fluid stops to come out from the rotary actuator (3), install the bottom plug (1) but do not tighten it at this time.

(5) Attach the pump to the grease nipple (4).

(6) Fill the rotary actuator with MIL-L46000 until the fluid flows through the top hole.

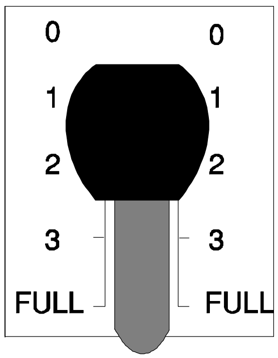
(7) Disconnect the pump from the grease nipple (4).

(8) Remove the bottom plug (1).

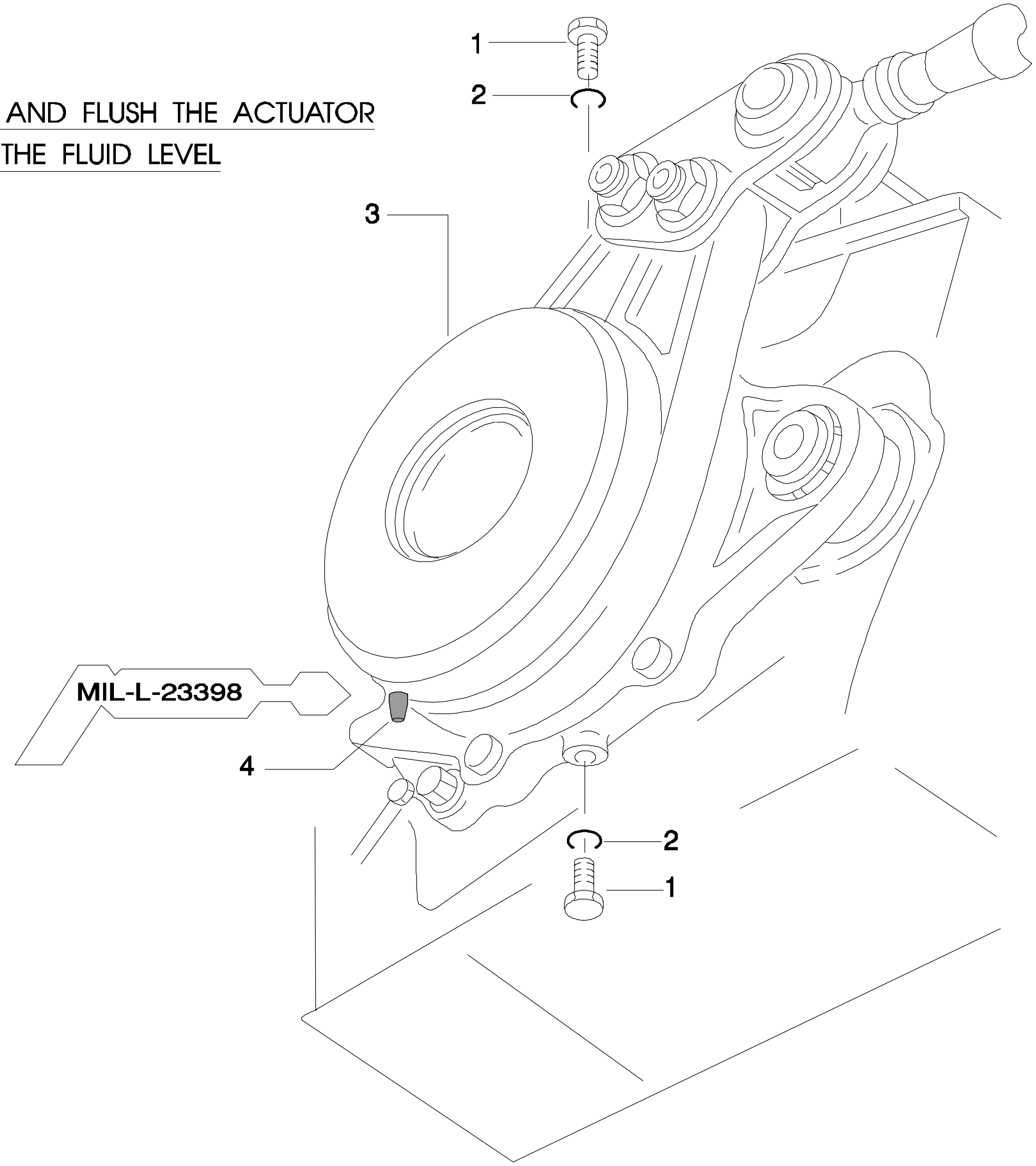
(9) When the fluid stops to come out and starts dropping, install the plugs (1) and torque them as indicated in your AMM.

NOTE : The simplified procedure is described here, refer to the AMM for the detailed procedure.

DRAIN, REFILL AND FLUSH THE ACTUATOR
TO CONFIRM THE FLUID LEVEL



FLAP POSITION 2



STUDENT NOTES