AEM 617

A320 FBW

Case study

The Airbus A320 is a fully fly-by-wire (FBW) aircraft (with 2 exceptions).

This aircraft is the 1st commercial transport FBW FCS. without a complete mechanical backup.

Objectives:

- Enhanced "protection" at the flight envelope boundary
- Load alleviation
- Efficient and ergonomic flight controls

*The computer won't let the pilot break the airplane

What are the disadvantages?

Air France 447

tiny.cc / AEM617 A320

airshow flyover
visual approach
"α protection mode"
elevators limited.

Safety:

- Redundancy 5 separate flight computers
- Mechanical Backup: Rudder + Horizontal trim (tested to show control over all envelope)
  - Rudder → roll → heading
  - Horizontal trim → pitch → altitude/altitude

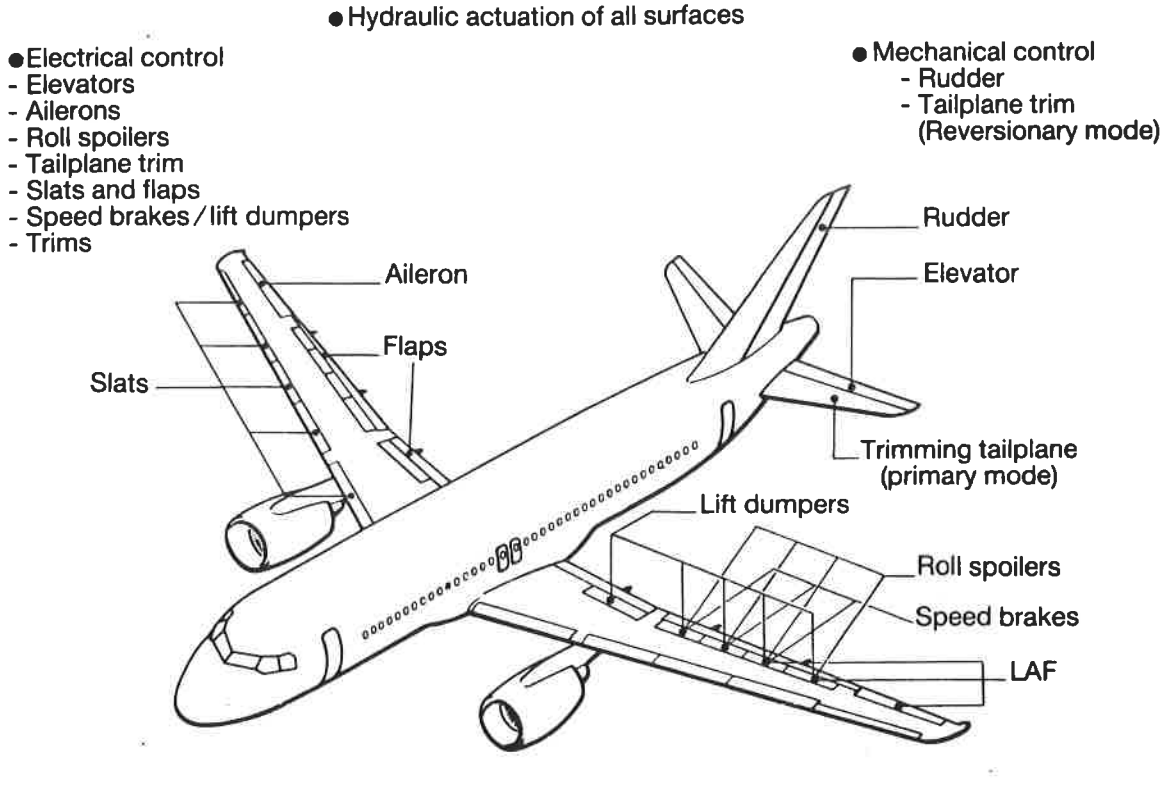


Figure 4-43. A320 Flight Control Surfaces. (Courtesy of Airbus Industrie)

Source:
Aircraft Flight Control Actuation System Design
Raymond and Chenoweth
SAE, 1993

System Controllability and Robustness Architecture

What is the minimum necessary equipment/controls to achieve a survivable landing?

- Altitude *
- Location *
- Heading *
- Airspeed *

In general, the equation of motion are coupled.

In practice, a pilot can fly with elevator, rudder, and thrust.

Airbus split the A320 architecture into 2 primary (yet redundant) systems.

- ELAC: 2 computers controlling elevators and ailerons.
- SEC: 3 computer controlling spoilers and elevators.
  plus electromechanical horizontal trim

The computers are supplied by two different companies (Intel 80286 and Motorola 68010). Each ELAC and SEC has a control unit and monitor unit (these units are physically separated). Software is different across systems and control/monitoring units.

Monitoring systems allow crosstalk between all 5 computers.

Also 2 FAC for rudder control
"Flight Augmentation Computers"

The A320 also has 3 separate hydraulic systems.

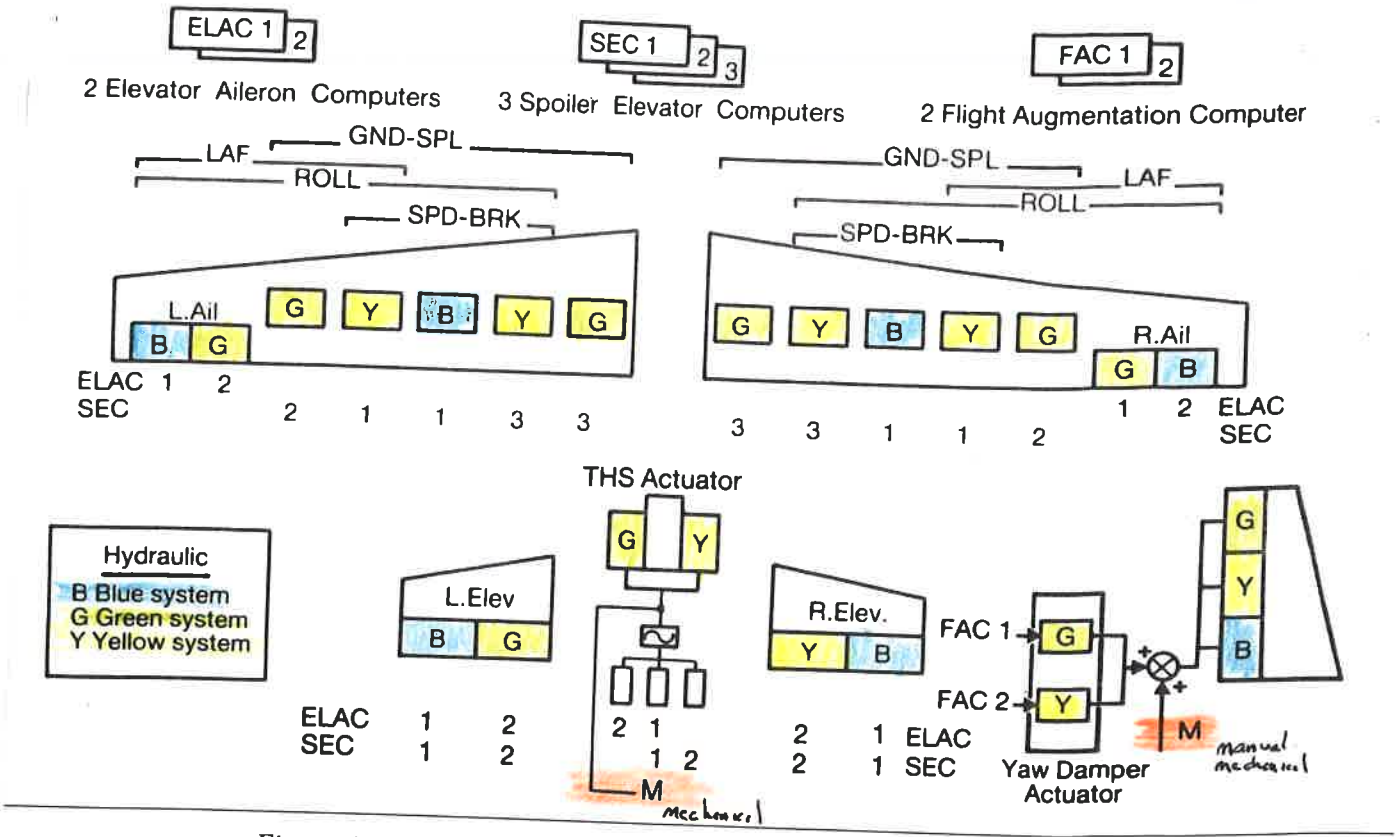


Figure 4-44. A320 EFCS Architecture. (Courtesy of Airbus Industrie)

A320 control routing redundancy (segregation)

S = Signal
M = Monitoring

= ELAC and SEC system

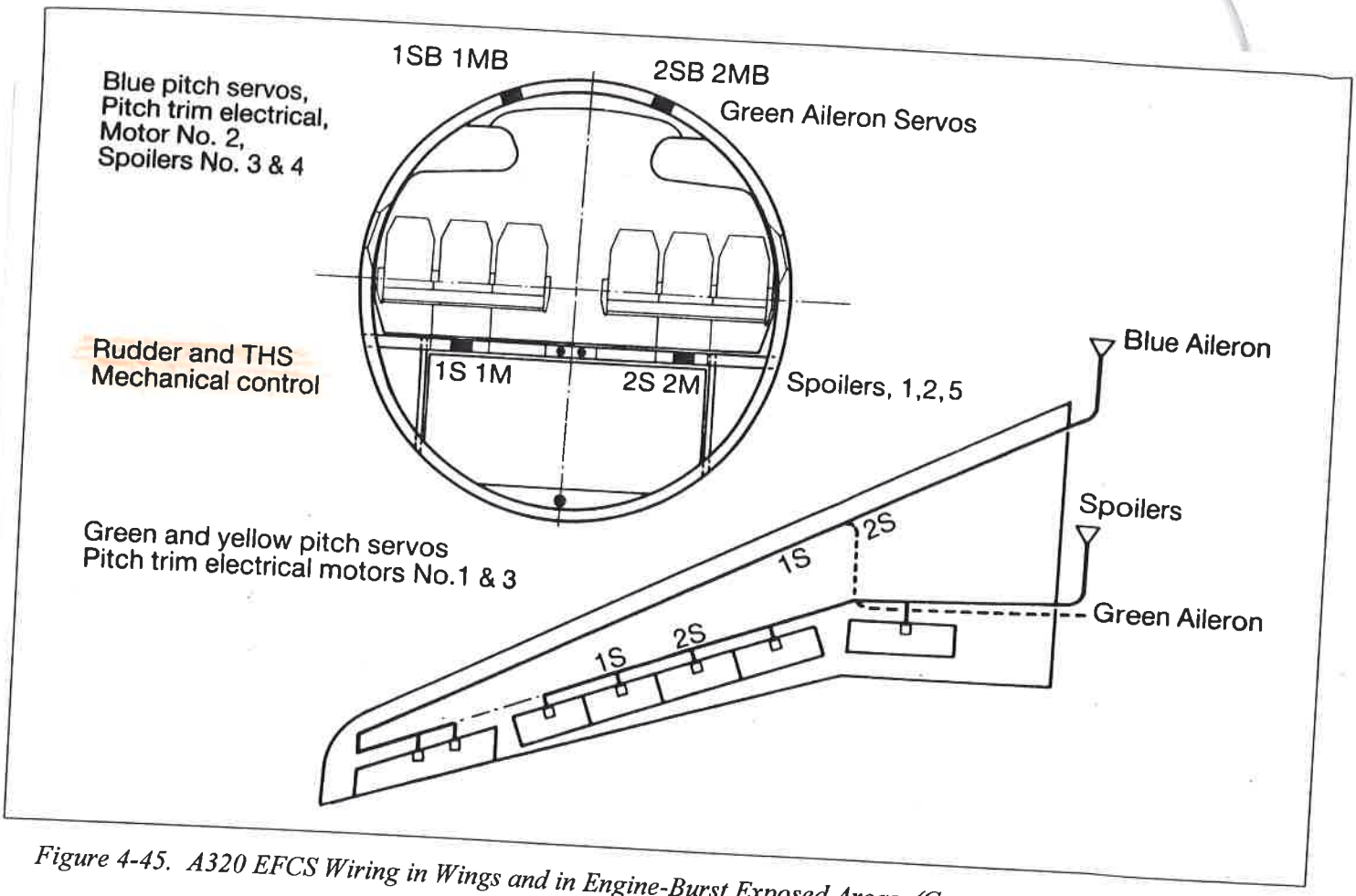


Figure 4-45. A320 EFCS Wiring in Wings and in Engine-Burst Exposed Areas. (Courtesy of Airbus Industrie)

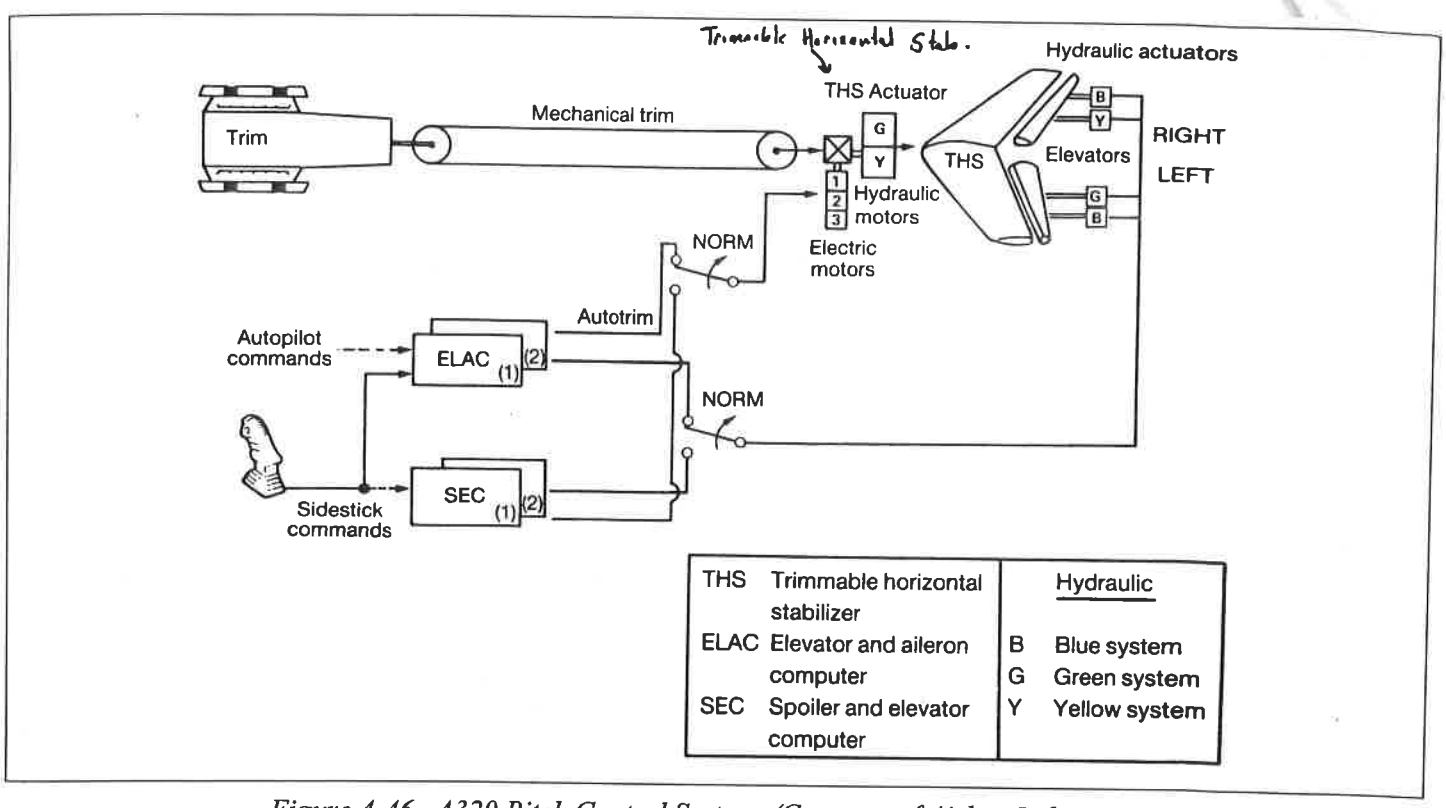


Figure 4-46. A320 Pitch Control System. (Courtesy of Airbus Industrie)

- Actuators center upon loss of signal
- Actuators operate in "damping" mode when in standby mode or if hydraulic pressure lost.
  Normal operation is one actuator "active" and other in "standby". No fighting.
- Mechanical trim has priority at THS actuator

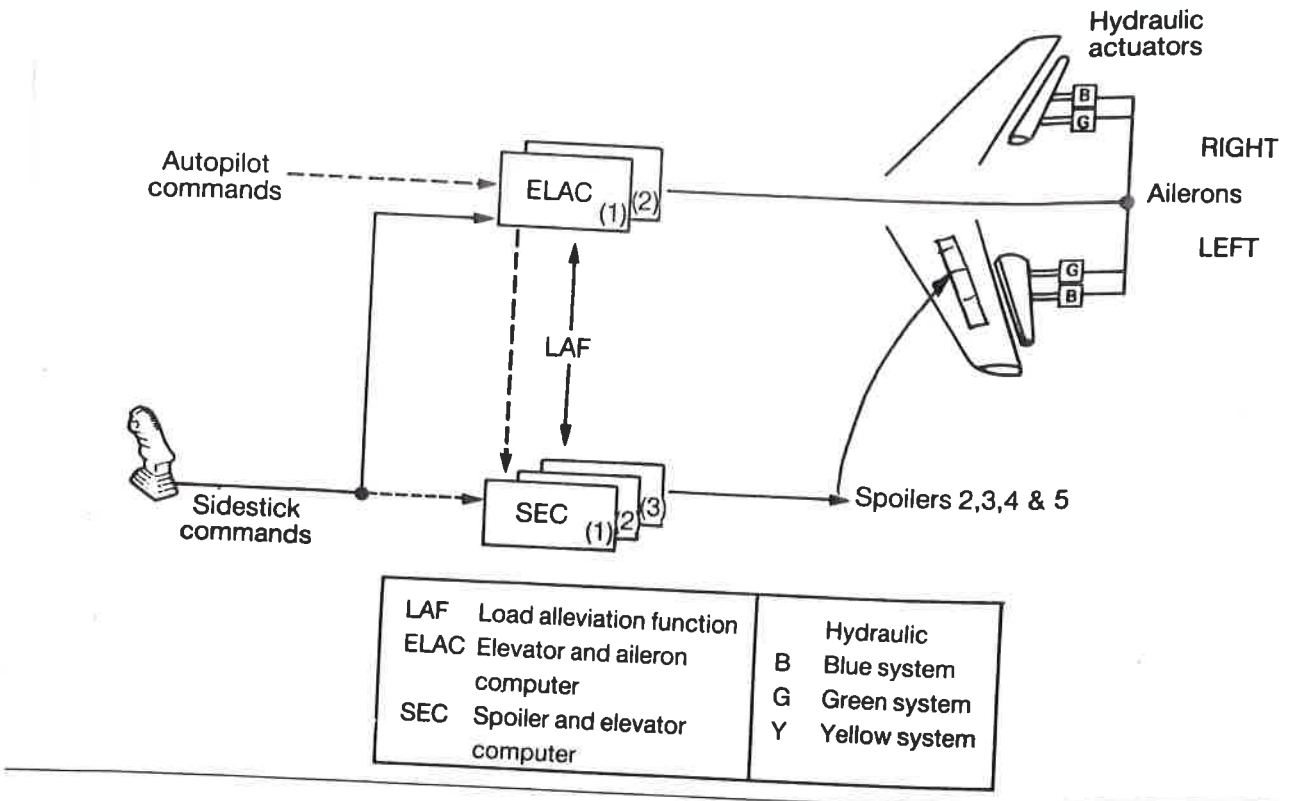
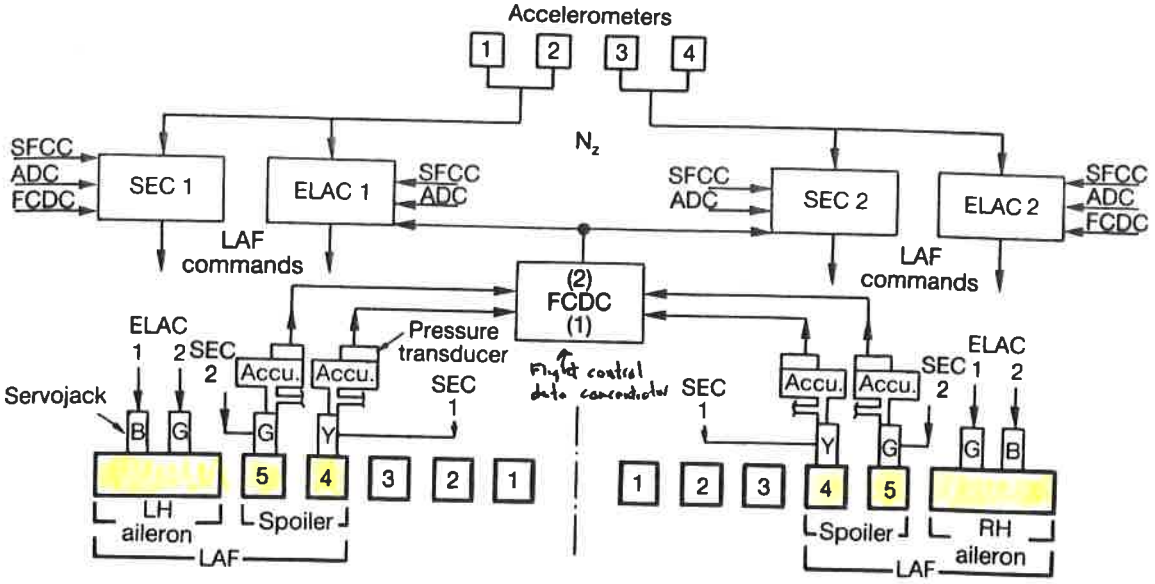


Figure 4-47. A320 Roll Control System. (Courtesy of Airbus Industrie)

LAF: Load Alleviation

Modify the spanwise lift distribution to minimize wing bending stresses during maneuvers and turbulence  vs

Controlls the outboard spoilers and ailerons on the A320.



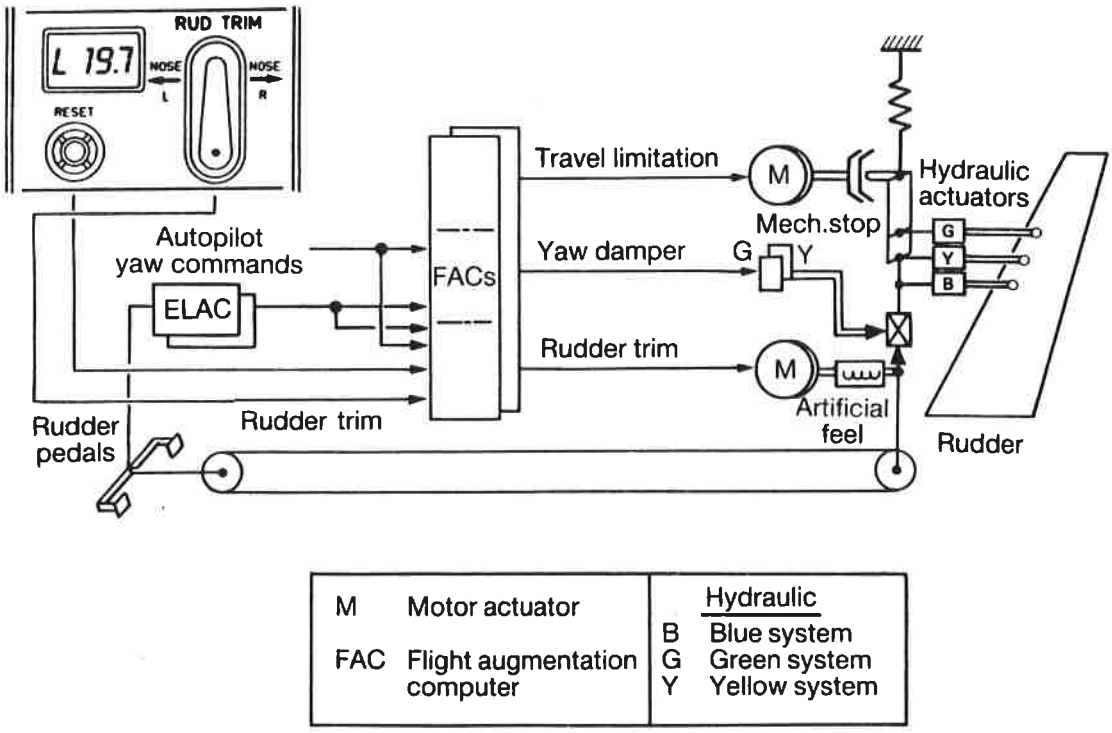


Figure 4-48. A320 Yaw Control System. (Courtesy of Airbus Industrie)

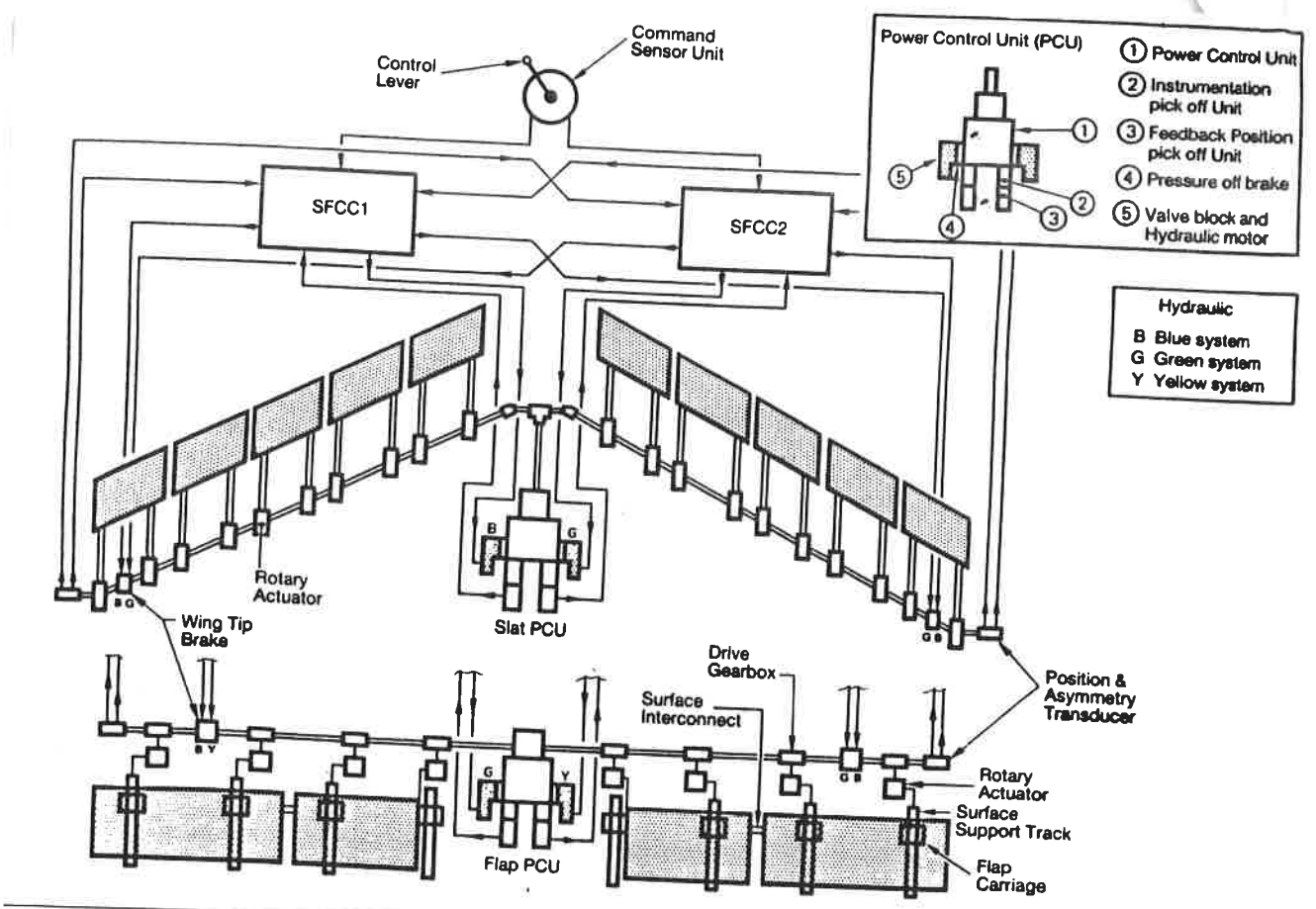


Figure 4-50. A320 Slat and Flap Control System. (Courtesy of Airbus Industrie)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