A320 FLIGHT CONTROL LAWS PROTECTION

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In modern aviation, computers protect the aircraft in flight. The computer computes the flight modes to control the flight. A flight control mode is a software algorithm that transforms movement of the stick into movements of the aircraft control surfaces. These are governed by computational laws i.e., some set of rules called "Control Laws" that will determine how the computer would determine a performance demand in terms of a control response. Failure of computational equipment or equipment providing data to computational equipment can cause a degradation of electronic flight control. This will result in change of flight control laws that can diminish or finish the safety protections. Main flight control laws are the Normal law, Alternate law and the Direct law.

- **NORMAL LAW**
  - **Pitch Control**
    - Load Factor Limit
    - Pitch Attitude
    - High AOA
    - High Speed
  - **Lateral Control**
  - **Load Alleviation Function**

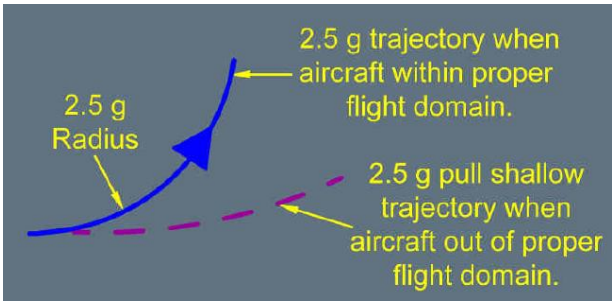
- **ALTERNATE LAW**
  - **Pitch Control WITH Reduced Protections**
    - Load Factor Limitation
    - Low Speed Stability
    - High Speed Stability
  - **Pitch Control WITHOUT Reduced Protections**
    - Load Factor Limitation

- **DIRECT LAW**
  - **Pitch Control**
    - Direct stick-to-elevator relationship.
    - No protections available.
  - **Lateral Control**
    - Direct stick-to-surface-position relationship.
    - No protections available.

NORMAL LAW > PITCH CONTROL

- Load Factor Limit Protection

  - Load factor protection enables immediate PF reaction, without any risk of overstressing the aircraft. An immediate 2.5g reaction provides larger obstacle clearance, than a hesitant & delayed high G Load maneuver (2 second delay).

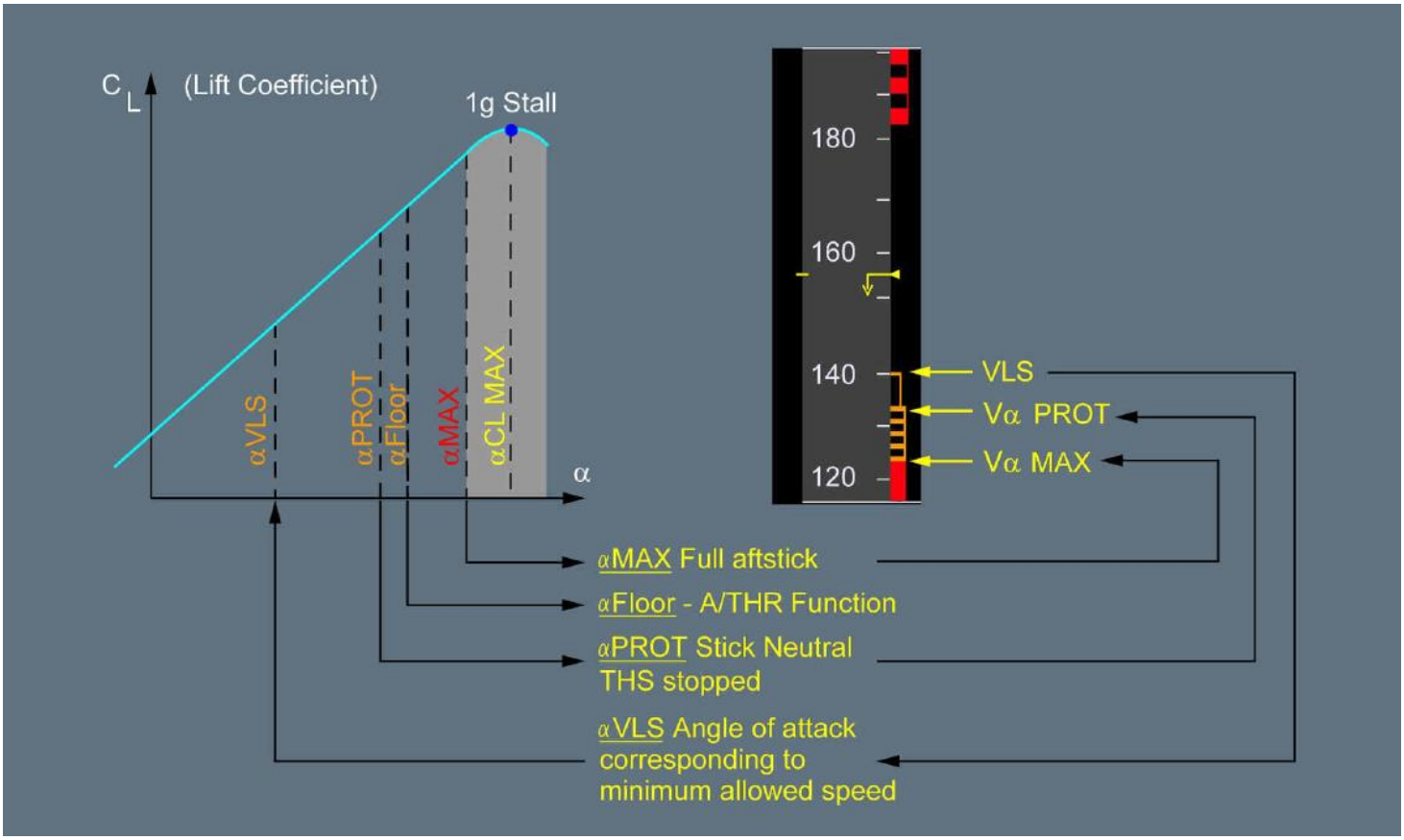


- Pitch Attitude Protection

  - 30° nose up in conf 0 to 3 (progressively reduced to 25° at low speed).
  - 25° nose up in conf FULL (progressively reduced to 20° at low speed).
  - 15° nose down (indicated by green = = symbols on the PFD's pitch scale).
  - FD bars disappear from PFD when pitch attitude exceeds 25° up or 13° down.
  - Pitch attitude protection enhances high speed, high AOA & load factor protection.

- High AOA Protection

  - When current AOA becomes greater than αPROT, the high AOA protection activates. Without input, the computers maintain the AOA equal to αPROT. The AOA can be further increased by flight crew input, up to a maximum value equal to αMAX. When the High AOA protection is activated, the normal law demand is modified and the sidestick input is an AOA demand, instead of a load factor demand. High AOA has priority over all protections.



- Level Flight – AP ON + A/THR ON – Minimum Speed will be VLS.

- Level Flight – AP ON + A/THR OFF – Minimum Speed will be αPROT.

  If thrust is idle at αPROT, aircraft will not maintain straight and level, it will pitch down and descend to maintain speed.

- Level Flight – AP OFF + A/THR OFF – Trimming stops at αPROT.

  If stick is held back deliberately, αFloor will be triggered & Go-Around thrust will be applied automatically regardless of thrust level position & A/THR engagement status.

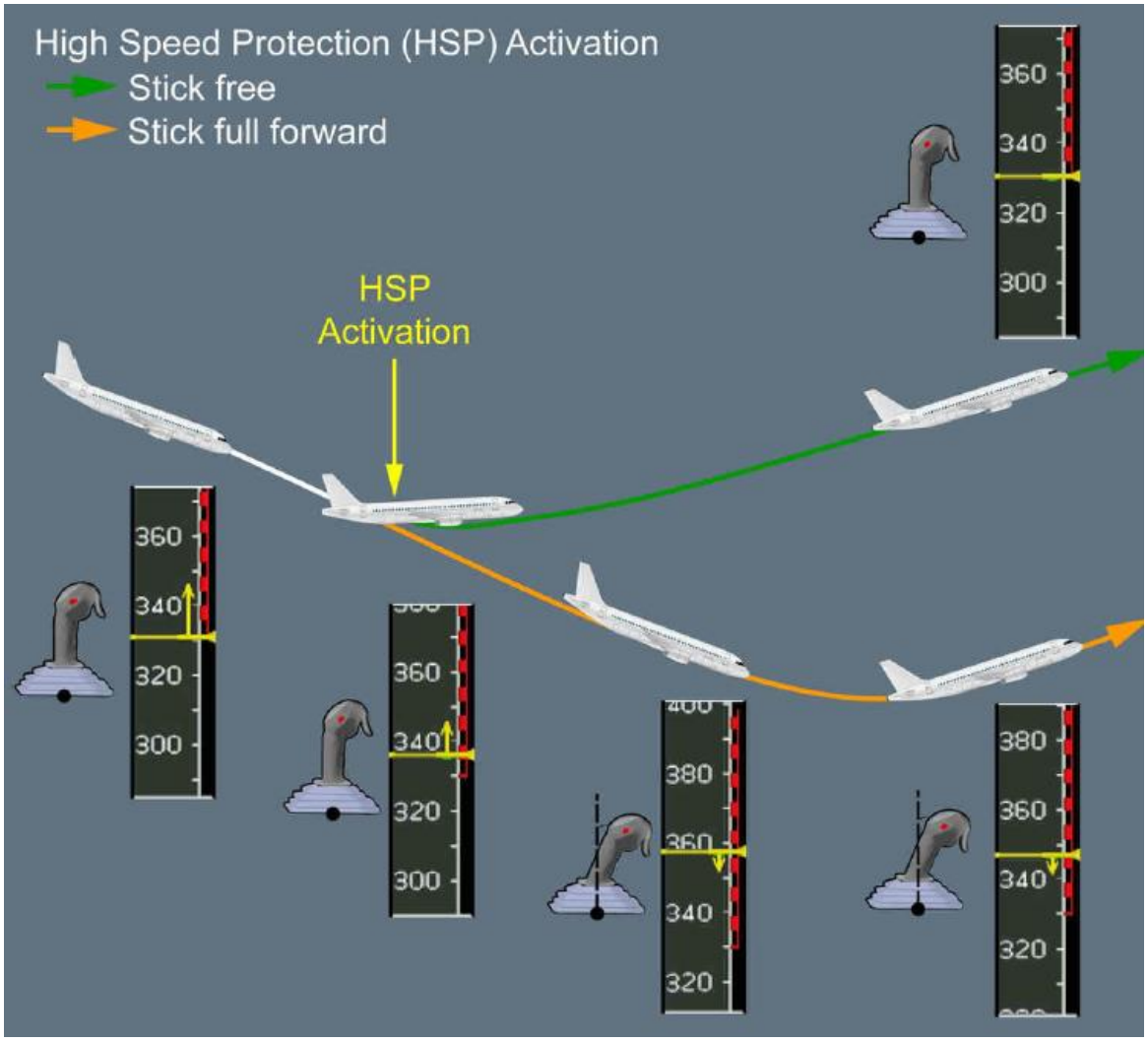
- Level Flight – AP OFF + A/THR OFF – AOA can be increased to a maximum of αMAX.

  αMAX is close to (slightly less than) 1 g stall speed. AOA will not exceed αMAX, even if sidestick is gently pulled all the way back. With αFloor active aircraft will start climbing. Without αFloor (alternate/direct law) aircraft will approach 1g stall speed & then stall.

- High Speed Protection – Activates at or above VMO/MMO

  - Effect on Pitch

    In a dive if there is no input on the sidestick, the aircraft will slightly overshoot VMO/MMO and fly back towards the envelope. If the sidestick is maintained full forward, the aircraft will significantly overshoot VMO/MMO. At approximately VMO + 16 kt / MMO + 0.04, the pitch nose-down authority smoothly reduces to zero.

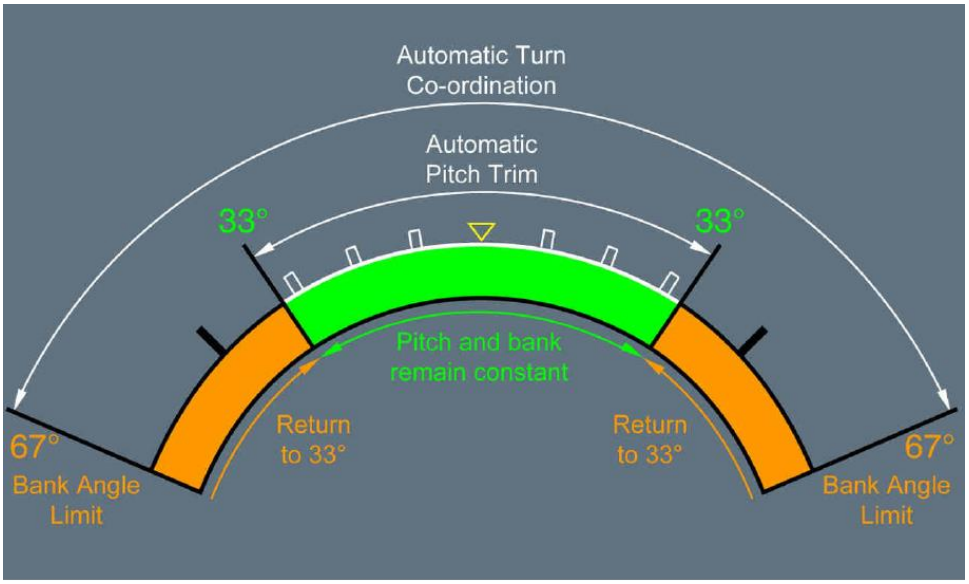


  - Effect on Bank

    High speed protection activated – Sidestick Released – Bank angle returns to 0° (instead of 33 ° in normal law). Bank angle limit is reduced from 67 ° to 40 °.

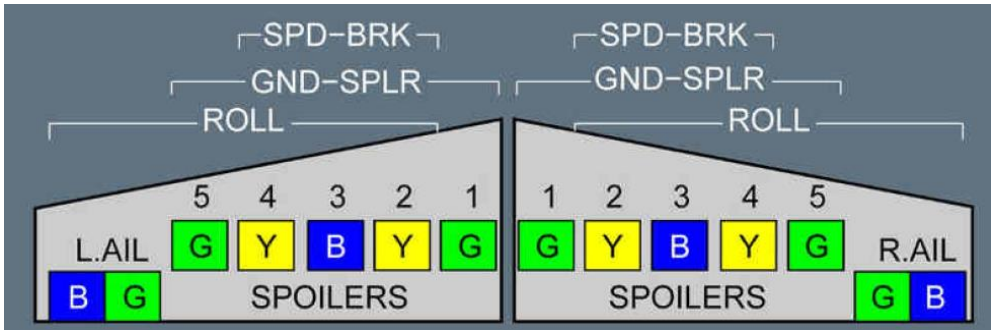
NORMAL LAW > LATERAL CONTROL

- Full sidestick deflection – Max bank angle 67 °.
- Full sidestick deflection with AOA protection active – Max bank angle 45°.
- Full sidestick deflection with high-speed protection active – Max bank angle 40°.
- Sidestick released at bank angle greater than 33° – Bank angle reduces to 33 °.
- Sidestick released with high-speed protection active – Bank angle reduces to 0°.
- Bank 0° to 33° – System holds roll attitude constant when sidestick is at neutral.
- Bank angle > 45° – AP Disconnects & FD Disappear. FD reappears when bank angle <40°.



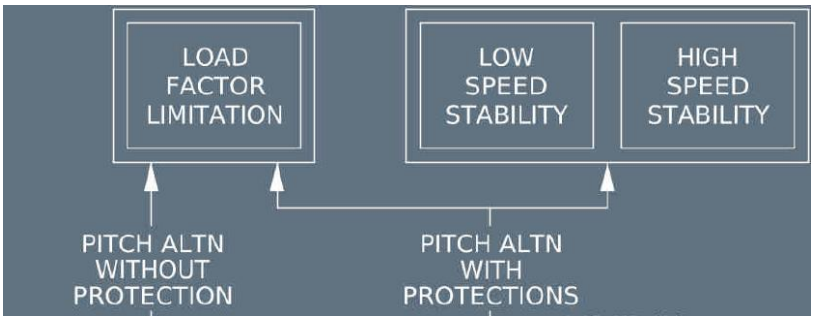
NORMAL LAW > LAF (LOAD ALLEVIATION FUNCTION)

- Permits to alleviate the wing structure loads achieved through upward deflection of two ailerons only, or two ailerons associated to spoilers 4 and 5.

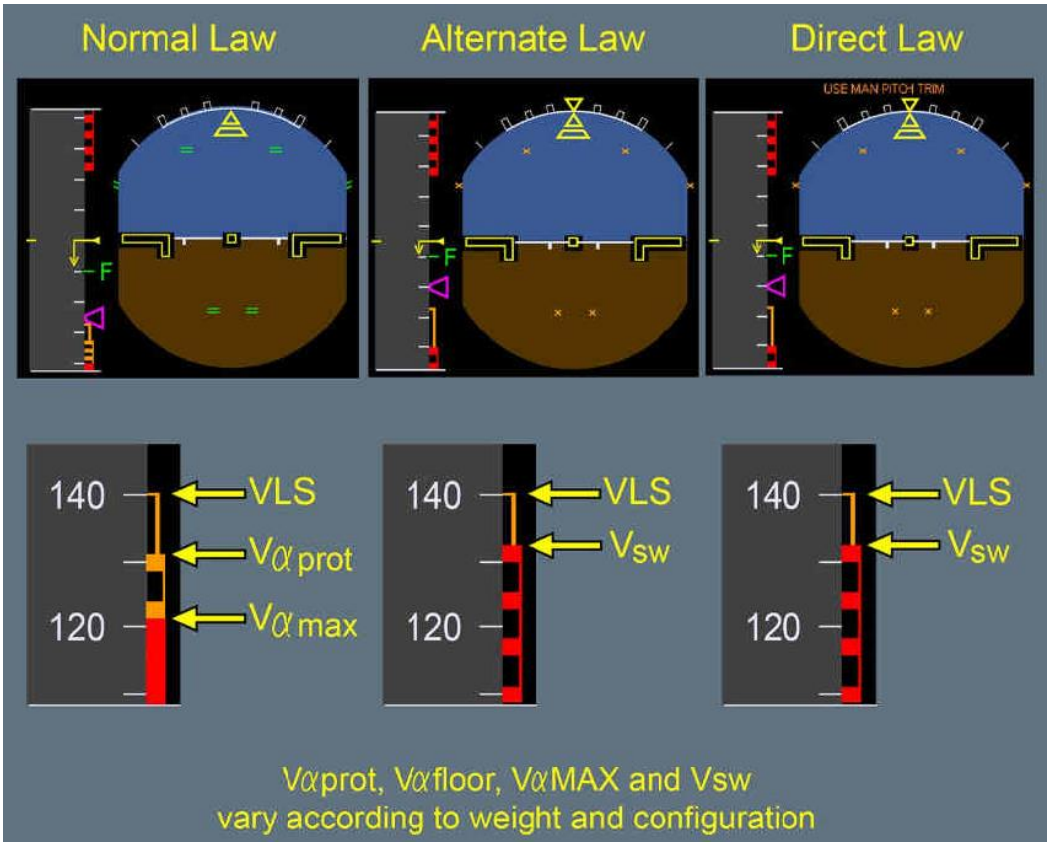


ALTERNATE LAW > PITCH CONTROL

- Without reduced protections:
  - **Load Factor Limitation**
    Similar to normal law.



- With reduced protections:
  - **Load Factor Limitation.**
    Similar to normal law.
  - **Low Speed Stability:** Active from about 5 to 10 kt above stall warning speed. A gentle progressive nose down signal is introduced. Pilot can override this. Audio stall warnings (crickets + "STALL" synthetic voice message) available.
  - **High Speed Stability:** Above VMO or MMO, a nose up demand is introduced. Pilot can override this. Aural overspeed warning (VMO +4 or MMO +0.006) remains available.



DIRECT LAW > PITCH CONTROL

- Direct stick-to-elevator relationship.
  Max elevator deflection varies as a function of CG to compromise between controllability (forward CG) and sensitivity (aft CG).
- No automatic trim.
- No protections available.
  Even the alpha floor function is inoperative.
- Overspeed and Stall warnings available as for alternate law.

DIRECT LAW > LATERAL CONTROL

Lateral control is governed by "Roll Direct Law" associated with "Mechanical Yaw Control".

- **Roll**
  - Direct stick-to-surface-position relationship.
  - System corresponds to slats/flaps position.
    Clean config – Roll rate 30°/sec, Slats extended – Roll rate 25°/sec
  - Ailerons + Spoilers 4 & 5 used to limit roll rate.
    Ailerons fail – Roll spoilers become active, Spoiler 4 fails – Spoiler 3 takes over
- **Yaw**
  - Mechanical control.
  - Yaw damping and turn coordination lost.