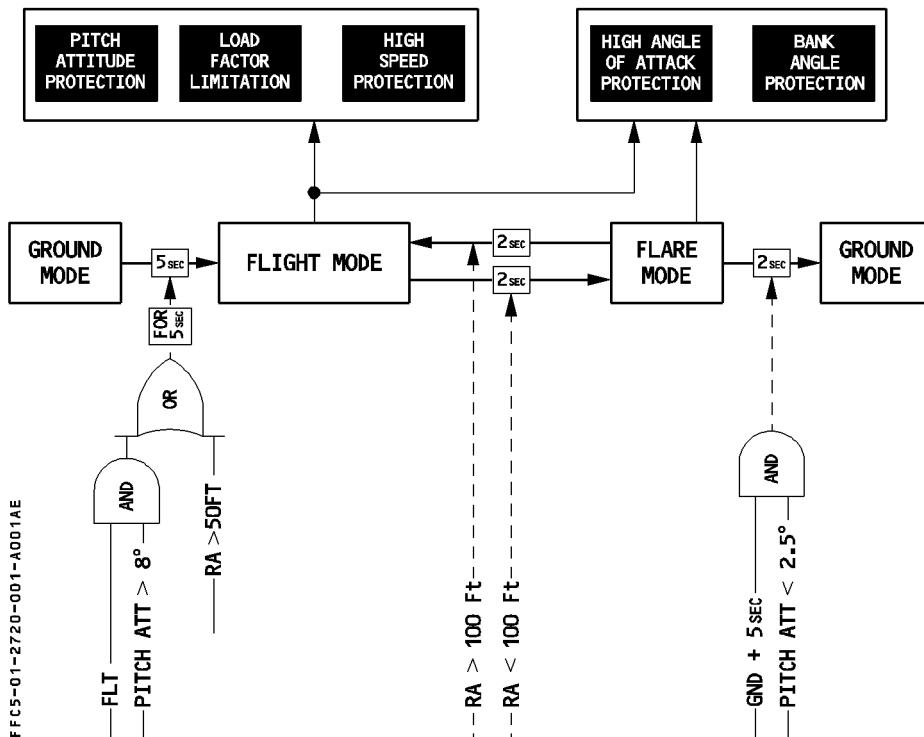


GENERAL

Flight control normal law provides:

- 3 Axis control
- Flight envelope protection
- Maneuver load alleviation

FOR INFO



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PITCH CONTROL

GROUND MODE

Ground mode is active on ground. It is a direct relationship between the sidestick and elevator deflection, without auto trim. The THS is automatically set at 5° up (inside the green band). Manual setting, according to the CG, has priority for takeoff.

The rotation maneuver is flown in direct law with full authority.

Immediately after the aircraft becomes airborne, the flight mode is progressively blended in. The reverse process occurs after touchdown.

FLIGHT MODE

The normal law flight mode is a load factor demand law with auto trim and full flight envelope protection. In manual flight, it provides elevator and THS control from the sidestick controllers to achieve a load factor proportional to stick deflection, independent of speed.

With the sidestick at neutral and the wings level, the system maintains 1 g in pitch corrected for pitch attitude. There is no need for the pilot to trim with speed or configuration changes.

With the autopilot engaged, it provides elevator and THS control according to autopilot and load factor demand. Pitch trim is automatic in both manual and autopilot mode.

In normal turns (up to 33° of bank), no pitch correction is required once the turn is established.

The flight mode is active from takeoff to landing, according to the logic (page 1).

Automatic pitch trim is frozen in the following cases:

- Manual trim order
- Radio altitude below 100 ft for flare
- Load factor lower than 0.5 g
- In high speed protection

When the angle of attack protection is active, the THS is limited between setting at entry in protection and 2° nose down (i.e. further nose up trim cannot be applied).

Similarly, when the load factor is higher than 1.3 g, or when the bank angle is outside $\pm 33^\circ$, the THS is limited between the actual setting and 2° nose down.

Control with autopilot engaged

- A force must be overcome to move the sidestick with the autopilot engaged. If the pilot moves the sidestick to overcome this force, the autopilot will disconnect.
- All protections remain effective.

FLARE MODE

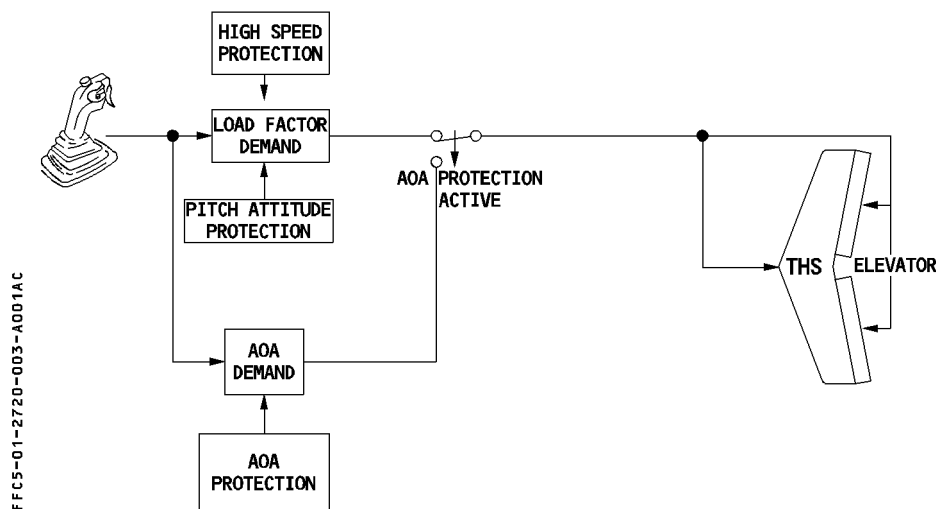
The flight mode changes to flare mode at landing when passing 100 ft.

The flare is flown in direct law (with some damping provided by load factor and pitch rate feed backs).

PROTECTIONS

The normal law provides complete flight envelope protection as follow :

- Load factor limitation
- Pitch attitude protection
- High angle of attack (AOA) protection
- High speed protection



LOAD FACTOR LIMITATION

The load factor is automatically limited to :

- + 2.5 g to – 1 g slats retracted
- + 2 g to 0 slats extended

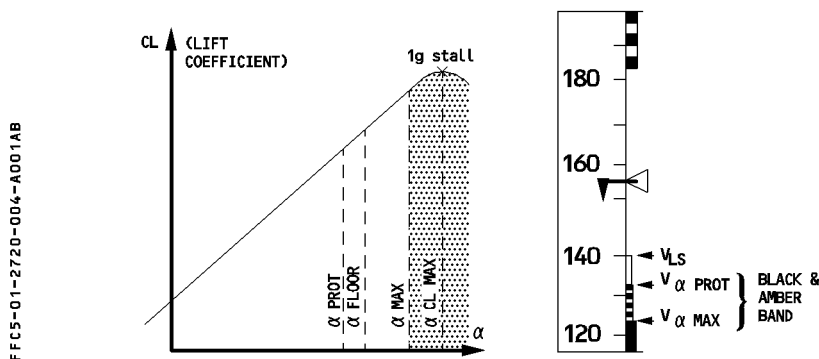
PITCH ATTITUDE PROTECTION

Pitch attitude is limited to 30° nose up (progressively reduced to 25° at low speed), and to 15° nose down (indicated by green symbols “=” on PFD pitch scale (Refer to 1.31.40)).

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HIGH ANGLE OF ATTACK PROTECTION

Under normal law, when angle of attack becomes greater than α prot, the system switches the elevator control from normal mode to a protection mode in which the angle of attack is proportional to the sidestick deflection. That is, in the α prot range, from α prot to α max, the sidestick commands α directly. However the angle of attack will not exceed α max, even if the pilot gently pulls the sidestick all the way back. If the pilot releases the sidestick the angle of attack returns to α prot and stays there. This protection, against stall and windshear, has priority over all other protections. The autopilot will disconnect if the protection is active.



- V_{α} prot, V_{α} max and α floor condition vary according to the weight and the configuration
- V_{α} prot and V_{α} max displayed on the PFD are computed by the PRIM.
- α floor activation logic is provided by the PRIM.

Note : 1. At takeoff α prot is equal to α max for 8 seconds.

2. α FLOOR is activated through autothrust system when:

- α is greater than a threshold depending on the aircraft configuration, the ground speed variation, and the difference between ground speed and air speed or,
- Sidestick deflection above 14° and:
 - pitch attitude greater than 25° , or
 - AOA protection active

3. α FLOOR inhibition (Refer to 1.22.30)

To leave the angle of attack protection the sidestick must be pushed :

- More than 8° forward, or,
- More than 0° forward for at least 1 second when $\alpha < \alpha$ max.

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HIGH SPEED PROTECTION

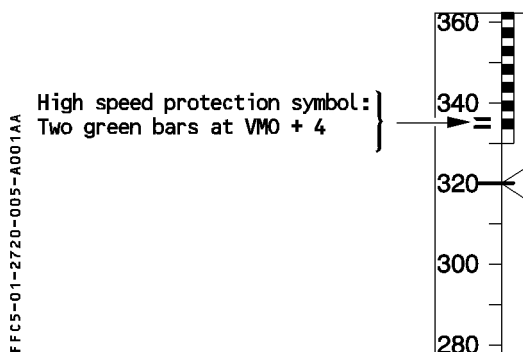
The aircraft automatically recovers following a high speed upset. Depending on the flight conditions (high acceleration, low pitch attitude), the High Speed Protection is activated at/or above VMO/MMO.

When it is activated, the pitch trim is frozen. Positive spiral static stability is introduced to 0° bank angle (instead of 33° in normal law), so that with the sidestick released, the aircraft always returns to a bank angle of 0°. The bank angle limit is reduced from 67° to 45°.

As the speed increases above VMO/MMO, the sidestick nose-down authority is progressively reduced, and a permanent nose-up order is applied to aid recovery to normal flight conditions.

The High Speed Protection is deactivated when the aircraft speed decreases below VMO/MMO, where the usual normal control laws are recovered.

The autopilot disconnects when high speed protection goes active.



Note : *OVERSPEED ECAM warning is provided at :*

- VMO + 4 kt
- MMO + 0.006

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LOW ENERGY WARNING

A low energy aural warning “SPEED SPEED SPEED” repeated every 5 seconds indicates to the pilot that the aircraft energy becomes lower than a threshold under which to recover a positive flight path angle through pitch control, the thrust must be increased.

It is available in configuration 2, 3 and full between 100 and 2000 ft.

The low energy warning is computed by the PRIM's from the following inputs:

- Aircraft configuration
- Air speed deceleration rate
- Flight path angle

It is inhibited when:

- TOGA is selected
- Below 100 ft RA
- Above 2000 ft RA
- Alpha floor or GPWS alert is triggered
- In alternate or direct law
- If both RA are failed

The low energy warning is triggered during deceleration before alpha floor (unless alpha floor is triggered by stick deflection), the delay between the two warnings depends on deceleration rate.

LATERAL CONTROL

LATERAL NORMAL LAW

When the aircraft is on the ground (in “on ground” mode), the sidestick commands the aileron and roll spoiler surface deflection. The amount of control surface deflection that results from a given amount of sidestick deflection depends upon aircraft speed. The pedals control rudder deflection.

When the aircraft is in the “in flight” mode, normal law combines control of the ailerons, spoilers (except N° 1 spoilers), and rudder (for turn coordination) in the sidestick. While the system thereby gives the pilot control of the roll and heading, it also limits the roll rate and bank angle, coordinates the turns, and damps the dutch roll.

The roll rate requested by the pilot during flight is proportional to the sidestick deflection, with a maximum rate of 15° per second when the sidestick is at stop.

When the aircraft is in “flare” mode, lateral control is the same as in “in flight” mode.

BANK ANGLE PROTECTION

Inside the normal flight envelope, the system maintains positive spiral static stability for bank angles above 33°. If the pilot releases the sidestick at a bank angle greater than 33°, the bank angle automatically reduces to 33°. Up to 33°, the system holds the roll attitude constant when the sidestick is at neutral. If the pilot holds full lateral sidestick deflection, the bank angle goes to 67° (indicated by a pair of green bar lines “=” on the PFD) and no further.

BANK ANGLE MAINTAINED WITH STICK NEUTRAL

0°

PILOT INPUT NEEDED
TO MAINTAIN BANK ANGLE

33°

33°

AUTOMATIC
PITCH TRIM

67°

67°

MAX BANK
ANGLE

FFC5-01-2720-007-A 100A

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If the angle-of-attack protection or high speed protection is operative, the bank angle goes to 45° and no further, if the pilot holds full lateral sidestick deflection. If high speed protection is operative, the system maintains positive spiral static stability from a bank angle of 0°, so that with the sidestick released, the aircraft always returns to a bank angle of 0°.

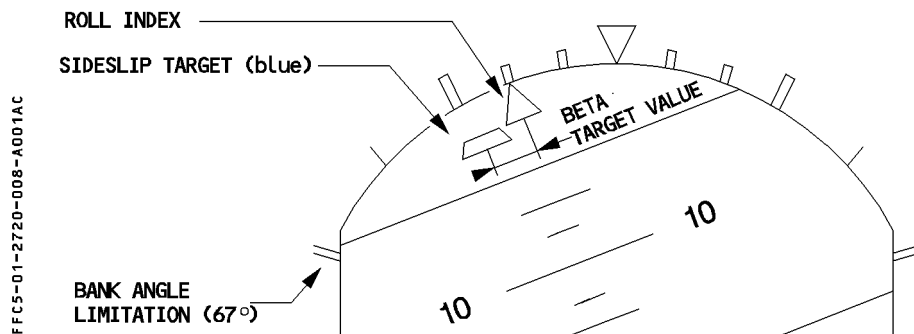
When bank angle protection is active, auto trim is inoperative.

If the bank angle exceeds 45°, the autopilot disconnects and the FD bars disappear. The FD bars return when the bank angle decreases to less than 40°.

SIDESLIP TARGET

Should an engine failure occur, the sideslip indication is slightly modified to ensure that optimum pilot rudder application is made to achieve optimum climb performance (ailerons to neutral and spoilers retracted).

In takeoff configuration, when asymmetrical thrust is detected (30 % N1) and at least one engine is above 80 % N1, the sideslip indication will change from yellow to blue.



Crew response is normal and instinctive:

- Zero, the beta target value for optimum performance with appropriate rudder application.
- Accelerate if beta target cannot be zeroed with full rudder.

The computation is made by the PRIM.

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MANEUVER LOAD ALLEVIATION (MLA)

The purpose of MLA is to redistribute the lift over the wing to relieve structural loads on the outer wing surfaces (bending moment).

The demanded load factor is maintained.

MLA utilizes spoilers 4, 5 and 6, and the ailerons.

The MLA becomes active when the sidestick is pulled less than 8° and the load factor is more than 2 g in which case :

- The ailerons are symmetrically deflected upwards :
 - Maximum 11° added to roll demand, if any.
- Spoilers 4, 5, 6 are symmetrically deflected :
 - Maximum 9° is added to roll demand, if any.
 - Deflection is proportional to the load factor, in excess of 2 g.
- An elevator demand is simultaneously applied to compensate for the pitching moment induced by spoilers and ailerons.

The load alleviation is only available when :

- The aircraft speed is above 250 kt.
- The FLAPS lever is in the 0 position.
- In normal or alternate law flight mode

The MLA has priority over the speedbrakes.

TURBULENCE LOAD ALLEVIATION (TLA)

The purpose of TLA is to reduce the wing bending moment caused by turbulence.

This function uses 3 specific Ng accelerometers located on each wing.

Ailerons and spoilers are linearly activated as a function of wind loads.