Safety first

The Airbus Safety magazine

Inappropriate V/S Target during Autoflight Mode Reversion

Two cases of inappropriate V/S target during an autoflight reversion to V/S mode after a go-around were recently reported to Airbus. In both cases, the inappropriate V/S target resulted in a pitch down command of the autopilot with high thrust. The flight guidance used the previously selected V/S value set during the preceding ILS glide slope intercept from above as a V/S target for the mode reversion.

This article describes one of these events in detail and explains the conditions that caused this autoflight behavior. It provides operational recommendations to flight crews to prevent and detect this situation. It also lists the system enhancements that were launched to avoid the use of an inappropriate V/S or FPA target during a mode reversion of the flight guidance.

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CASE STUDY

Event Description

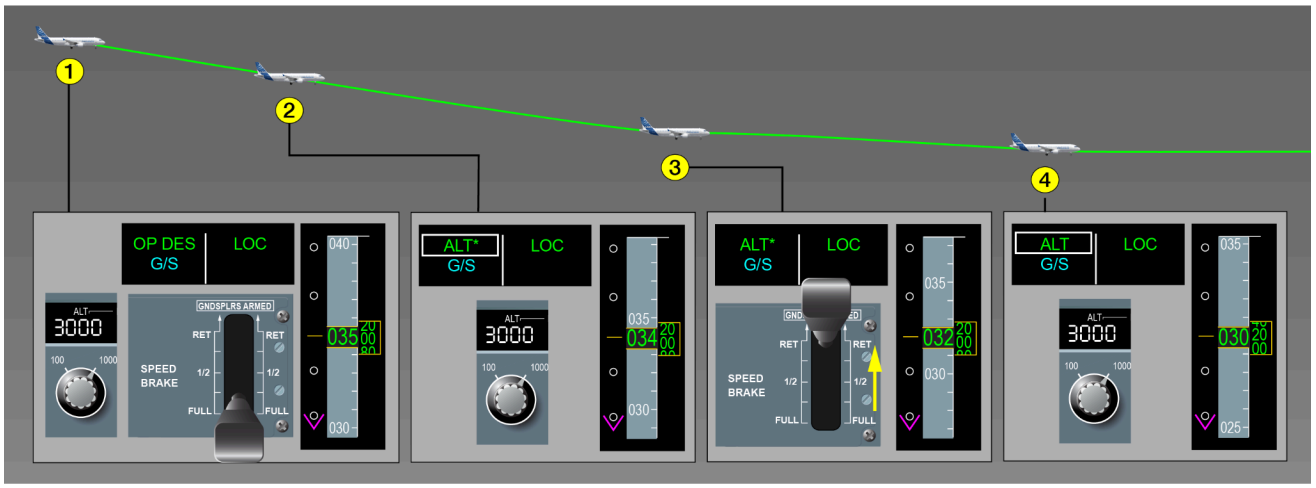
An A320 aircraft was descending toward its destination airport in IMC and the flight crew prepared for an ILS approach. Late clearance from air traffic control meant that the aircraft was high. The aircraft captured the localizer, but was above the ILS glide slope **(fig.1)**.

① At 3 500 ft, the aircraft was in OP DES I LOC mode with AP, FD, and autothrust ON. The selected altitude was 3 000 ft, the speed brakes were fully deployed, and speed was selected at 174 kt. Flaps configuration was CONF 2 and the landing gear was down.

② At approximately 3 400 ft, the ALT* mode engaged.

③ At 3 200 ft, the flight crew retracted the speed brakes and twice attempted to engage the V/S mode by pulling the V/S/FPA knob, but the ALT* mode reengaged 1 s after each attempt.

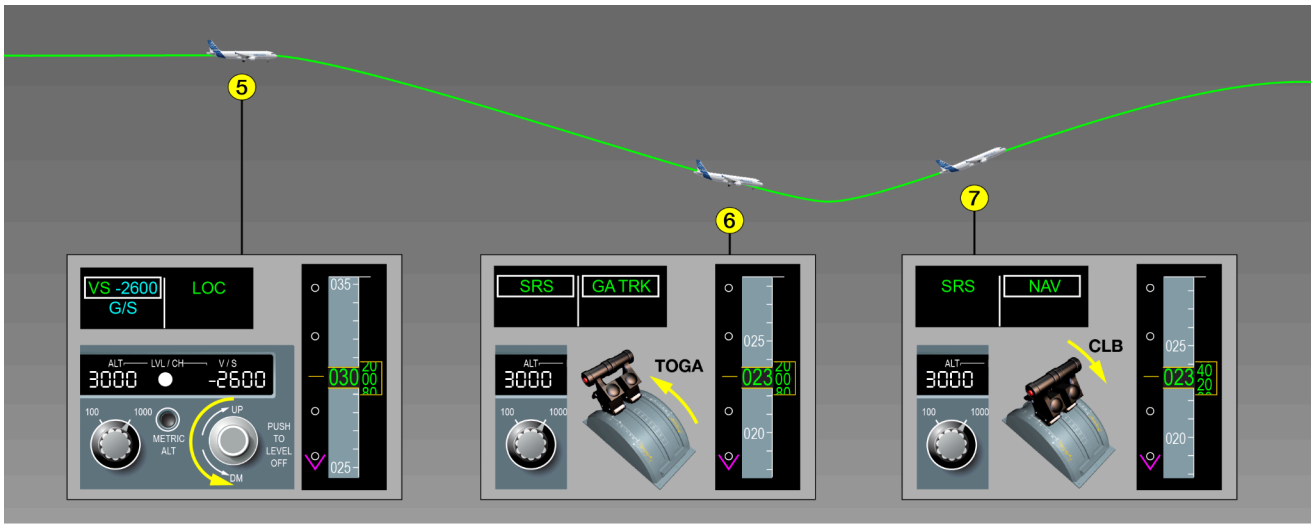
④ At 3 000 ft, the ALT mode engaged and the aircraft leveled off.



(fig.1) Event description (1 of 3)

⑤ The flight crew then pulled the V/S/FPA knob to engage the V/S mode and selected a V/S value of -2 600 ft/min on the FCU. The aircraft began to descend.

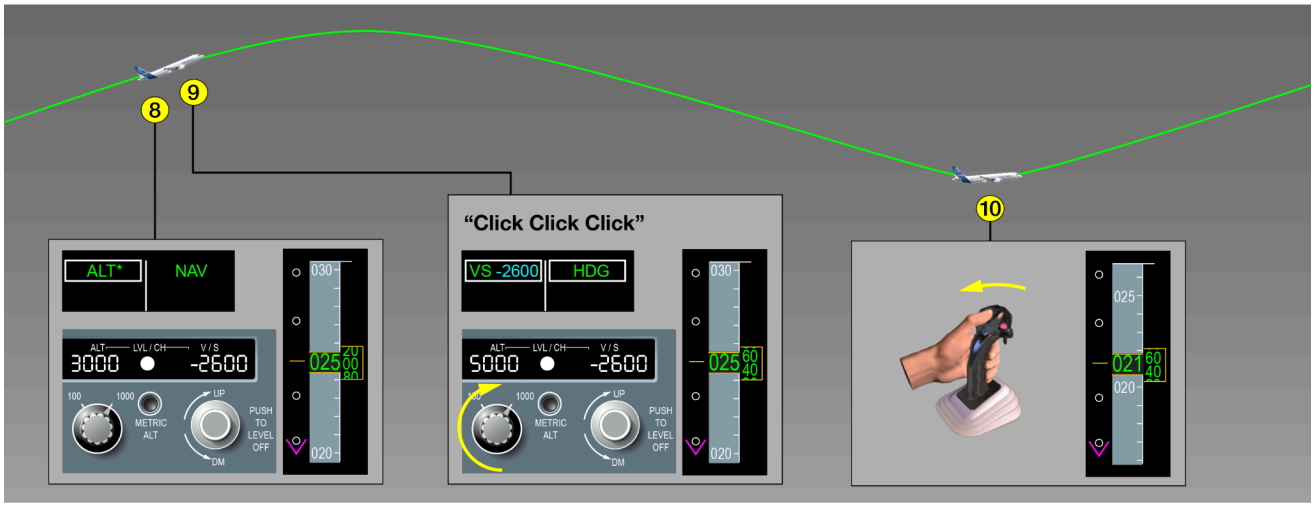
⑥ At approximately 2 300 ft (1 600 ft RA), the aircraft was still too high above the glide slope and the flight crew pushed the thrust levers to TOGA to initiate a go-around with the autopilot engaged. The aircraft started to climb toward the 3 000 ft altitude that was still selected on the FCU. The NAV mode engaged shortly after and ⑦ the PF moved the thrust levers back to the CLB detent at approximately 2 700 ft.



(fig.2) Event description (2 of 3)

⑧ The ALT* mode engaged at approximately 2 500 ft. ⑨ The flight crew immediately increased the altitude target from 3 000 ft to 5 000 ft on the FCU. As a result, the flight guidance reverted to V/S I HDG modes with associated alerts (triple-click sound, white box on FMA, and FD bars flashing for 10s). The aircraft pitch began to decrease. It climbed up to approximately 2 950 ft and then started to descend and accelerate. At 2 800 ft, the aircraft vertical speed reached -2 600 ft/min and remained constant until ⑩ the flight crew manually took over by pulling the sidestick. The aircraft reached 2 100 ft (1 400 ft RA) and started to climb again.

The flight crew later reengaged the autopilot and successfully performed a second ILS approach.



(fig.3) Event description (3 of 3)

Event Analysis

Reversion to the previously selected V/S value

When the flight crew increased the selected altitude from 3 000 ft to 5 000 ft on the FCU in step ⑨, the ALT* mode was engaged. This triggered a reversion to the V/S mode as per flight guidance logic. Since the V/S value was modified shortly before the go-around, it was still in the memory and displayed on the FCU. This led the V/S mode to use this previously selected value instead of the current aircraft V/S. We will describe this inappropriate behavior later in this article.

Flight crew reaction

It took more than 30 s from the mode reversion to V/S - 2600 in step ⑨, and 24 s from the start of the pitch down, for the flight crew to realize that the aircraft did not respond as expected.

AUTOFLIGHT SYSTEM BEHAVIOR

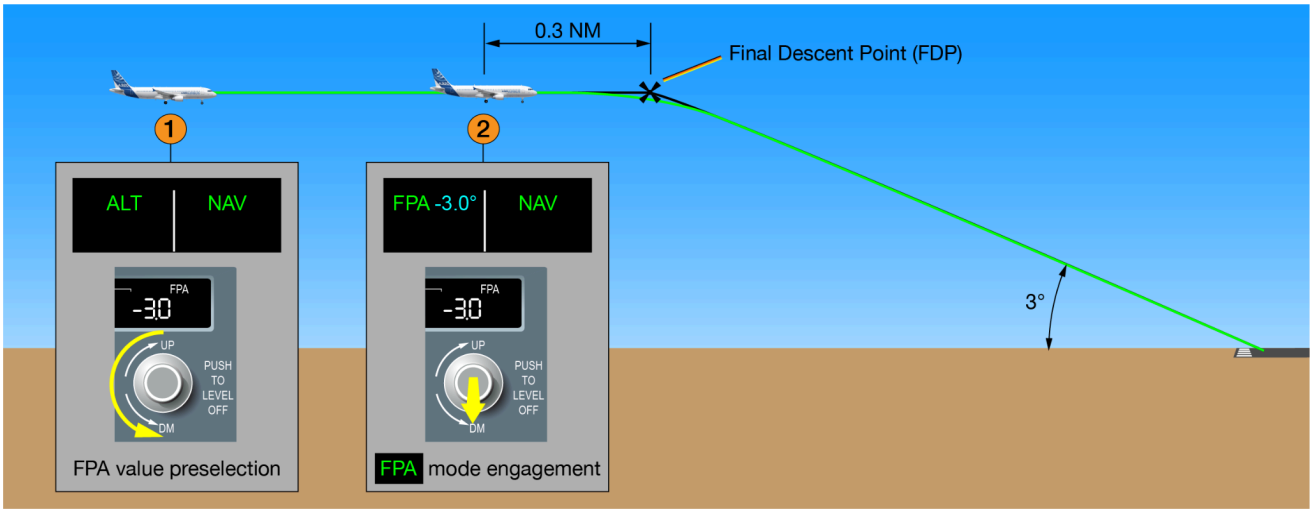
The event described above is due to a combination of two functions of the flight guidance system: The **V/S or FPA preselection** function and the **reversion to V/S or FPA modes.**

V/S or FPA Target Preselection

The V/S or FPA target preselection enables the flight crew to preselect a V/S or FPA target to be prepared to activate the associated flight guidance mode when appropriate. To do so, when the flight crew selects a V/S or FPA target on the FCU, this preselected value is **stored in the memory and remains displayed on the FCU for 45 s** (10 s on A300, A310, and A300-600 aircraft) to activate the guidance mode later.

INFORMATION

The duration of the V/S or FPA preselected value stored in the memory was increased from 10 s (on A300, A300-600, A310 aircraft) to 45 s for the A320 family, A330, A340, A350, and A380 aircraft. It enables the flight crew to ① preselect an FPA value earlier while the aircraft flies toward the Final Descent Point (FDP) during an approach using FPA guidance, in order to ② anticipate the engagement of the FPA mode when the aircraft reaches the FDP.



(fig.4) Preselection of the FPA value is used during approach using FPA guidance

Mode Reversion to V/S or FPA modes

The flight guidance automatic mode reversion to V/S or FPA modes is a logic designed to maintain the current aircraft trajectory when the altitude selection by the flight crew is inconsistent with the objectives of the current guidance mode. In the event described in this article, the reversion was triggered by changing the target altitude while the autopilot was in the ALT* altitude capture mode.

FCOM **DSC-AUTO FLIGHT - FLIGHT GUIDANCE - AP/FD MODES - V/S / FPA MODE** provides all the conditions for reversion to V/S or FPA modes.

An Inappropriate Combination

During a reversion to V/S or FPA modes, the flight guidance V/S or FPA target usually synchronizes with the current aircraft V/S or FPA in order to maintain the aircraft trajectory. However, if a V/S or FPA value is selected on the FCU and if the mode reversion happens within 45 s (10 s on A300-600 and A310 aircraft), the flight guidance V/S or FPA target synchronizes with this selected value.

This inappropriate combination of the V/S or FPA target preselection function with the mode reversion function may cause inappropriate behavior of the flight guidance as seen in the previous example.

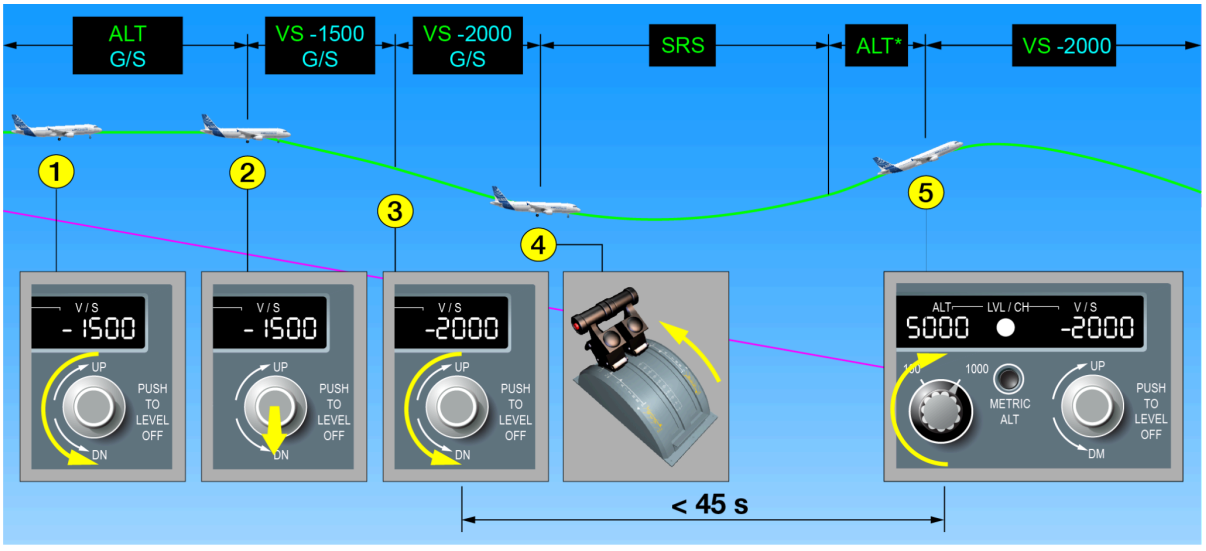
The shorter time that the selected value on A300-600 and A310 aircraft is stored in the memory significantly reduces the probability of mode reversion to the selected value within 10 s after the selection.

Several scenarios can lead to this inappropriate behavior, but not all aircraft are concerned due to some differences in their guidance logic.

Scenario 1: Go-around during glide slope intercept from above (A300-600 A310 and A320 family aircraft only)

The most common scenario where the flight crew may face this issue is a go-around during or after a glide slope intercept from above, as in the example described earlier in this article. ① A V/S value is preselected, ② V/S mode is engaged and ③ the V/S may be adjusted. ④ A go-around is then performed. ⑤ If the mode reversion happens within the 45 s after the V/S value preselection or last V/S modification, the inappropriate behavior will occur.

Only A300-600, A310, and A320 family aircraft are concerned. On A330, A340, A350, and A380 aircraft, the V/S or FPA preselected value is reset as soon as the V/S or FPA is engaged.



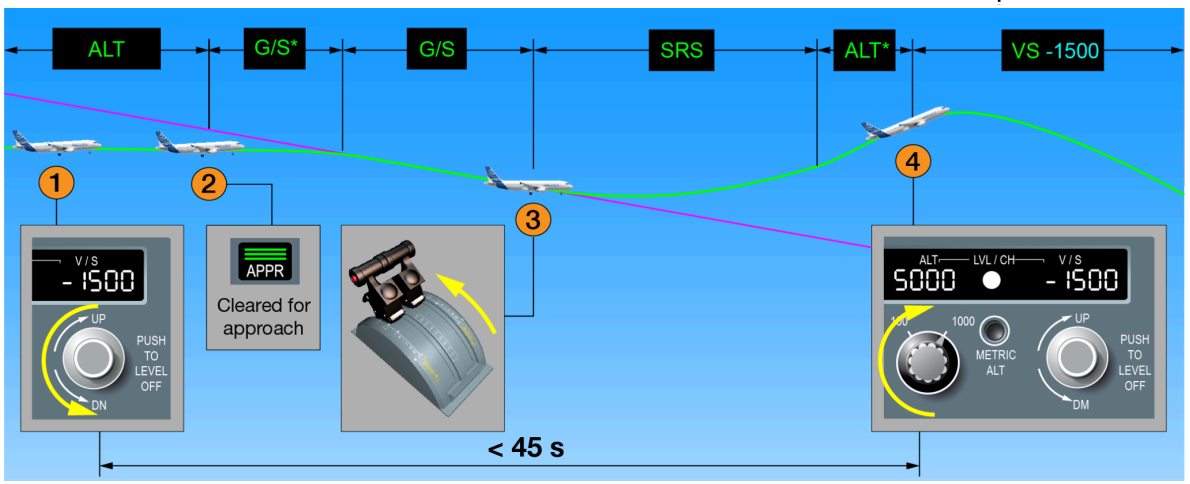
(fig.5) Scenario 1: Go-around during glide slope intercept from above (A300-600 A310, and A320 family aircraft only)

Scenario 2: Go around after glideslope interception with a preselected V/S (without engagement of the V/S mode)

In this case, ① a negative V/S value is preselected in anticipation of a glide slope intercept from above due to possible late ATC clearance. ② When cleared for approach, the flight crew presses the APPR pushbutton and G/S* mode engages, followed by G/S mode. ③ A go-around is performed. ④ If a mode reversion happens less than 45 s after the V/S preselection, the preselected negative V/S value is used.

All aircraft are concerned by this scenario, except A220 aircraft and A350 aircraft that are equipped with PRIM 14.1. (because the V/S or FPA selected value is reset at go-around engagement with PRIM 14.1).

(fig.6) Scenario 2: Go around after glideslope interception with a preselected V/S (without engagement of the V/S mode)



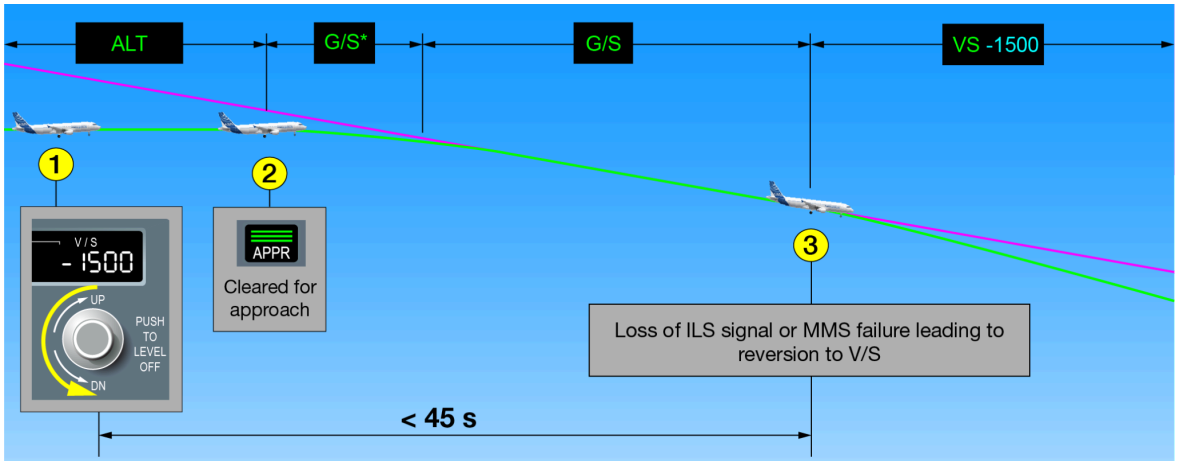
Scenario 3: Mode reversion due to the loss of an approach mode

In this scenario, ① a V/S or FPA value was preselected, as it was for scenario 2, and ② Approach mode is engaged when cleared by ATC. A mode reversion happens during the next 45 s after the preselection due to a loss of approach mode for reasons such as:

- G/S or F-G/S, APP DES or FINAL APP mode disengagement (e.g. loss of ILS signal, MMR failure, loss of flight plan, etc.)
- LOC or F-LOC or NAV mode disengagement
- The flight crew selects a target altitude higher than the actual aircraft altitude on FCU in DES or OP DES mode.

In this case, the effect on the trajectory is generally limited due to an already descending trajectory. It may be more difficult for the flight crew to detect the behavior.

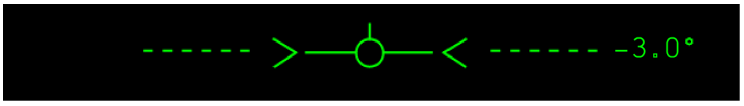
(fig.7) Scenario 3: Mode reversion due to the loss of an approach mode



Scenario 4: Visual manual approach using HUD

When performing a visual manual approach using the Head Up Display (HUD), the flight crew may select the FPA value corresponding to the final approach path on the FCU as a guidance **(fig.8)**.

If a go-around is performed the FD will come ON and SRS mode will engage. If a mode reversion happens within 45s after the last selection of the FPA value, the guidance mode will revert to V/S mode using V/S value corresponding to the FPA selected value, typically around -700 ft/min for a -3° FPA.



(fig.8) Selection of the FPA during a visual approach using FPA mode can also lead to the unintended behavior if a mode reversion happens within the next 45 s.

OPERATIONAL CONSIDERATIONS

Flight crews can identify an occurrence of an inappropriate V/S target during autoflight mode reversion thanks to several cues.

Aural and visual alerts

When a reversion to V/S or FPA mode occurs, the triple-click (except on A300-600 and A310 aircraft), FD flashing and guidance mode boxing on the FMA triggers to attract the attention of the flight crew who can check the reversion parameters.

Understand your FMA at all times

Careful monitoring and understanding of the FMA, as stated in the "Airbus Golden Rules for Pilots" will enable the flight crew to detect the reversion to V/S or FPA mode, and detect any inappropriate V/S or FPA target value.

Effect on the pitch

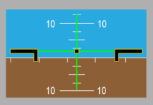
An unexpected pitch command by the autopilot can also be the sign of an inappropriate V/S or FPA target after a mode reversion. Note that in scenario 3 described above (mode reversion due to the loss of an approach mode), the unexpected autopilot pitch command may be limited and, therefore, difficult to perceive.

(fig.9) Several cues enable the flight crew to detect an inappropriate V/S target during an autoflight mode reversion

Cues of inappropriate V/S Target during autoflight mode reversion:

"Click Click Click"

Triple-click aural alert



Flashing FD bars for 10s

Inapropriate V/S or FPA on the FMA

Unexpected autopilot pitch command*

*The autopilot pitch command may be difficult to perceive in some situations.

Importance of the Pilot Monitoring

The pilot monitoring plays an important role in detecting the issue and alerting the pilot flying when the pilot flying does not detect the inappropriate behavior.

Take action if things do not go as expected

If the inappropriate behavior occurs, the flight crew should take appropriate action as per the golden rules.

SYSTEM ENHANCEMENTS

System enhancements are available, or will be made available on most of the concerned aircraft to prevent the inappropriate combination of the V/S or FPA Target Preselection function with the Mode Reversion function.

Enhancement 1: Reset of the V/S or FPA Preselected Value after V/S or FPA Mode Engagement

Whenever a V/S or FPA target is preselected in the FCU, if the flight crew engages V/S or FPA mode, the preset value is used for the guidance and is reset when the V/S or FPA mode engages. It prevents the use of a preselected value in a subsequent reversion to V/S or FPA as in the example described in this article but also in other phases of flight.

This modification is already installed on A330, A340, A350 and A380 aircraft **(table 1)**. It is planned to be introduced on A320 family aircraft. No availability date was defined at the time of authoring of this article.

Aircraft	A300/ A300-600/ A310	A320 Family	A330	A340	A380	A350	A220
Availability	Not planned	To be defined	Already installed	Already installed	Already installed	Already installed	N/A

(table 1) Availability of the reset of the V/S or FPA preset value after V/S or FPA mode engagement

Enhancement 2: Reset of the V/S or FPA Preselected Value at Go-around Engagement

This modification cancels any V/S or FPA preselected value when the flight crew performs a go-around. This prevents the use of an inappropriate V/S of FPA value if V/S or FPA mode was not engaged before the go-around.

This enhancement was already implemented on A350 aircraft in PRIM P14.1 standard certified in December 2022. The enhancement will be introduced on A320 family, A330, and A380 aircraft **(table 2).**

Aircraft	A300/ A300-600/ A310	A320 Family	A330	A340	A380	A350	A220
Availability	Not planned	To be defined	Planned on FMGEC H8+ (Q1 2025)	Not planned	Planned for PRIM P14	PRIM P14.1 (DEC 2022)	N/A

(table 2) Availability of the reset of the V/S or FPA preselected value at go-around engagement

Enhancement 3: Reset of the V/S or FPA Preselected or selected Value in the case of a reversion to V/S or FPA Mode

This enhancement ensures that the current V/S or FPA is used during a mode reversion so that the current trajectory is maintained.

This enhancement is planned to be installed on A320 family, A330, A350, and A380 aircraft **(see table 3)**.

Aircraft	A300/ A300-600/ A310	A320 Family	A330	A340	A380	A350	A220
Availability	Not planned	To be defined	To be defined	Not planned	Planned for PRIM P14 (Batch 8)	Planned for PRIM P15	N/A

(table 3) Reset of the V/S or FPA preselected or selected value in the case of a reversion to V/S or FPA mode

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V/S or FPA Target Preselection and Mode Reversion to V/S or FPA mode are two useful functions of the flight guidance system. However, in certain circumstances, their combination may create inappropriate behavior of the flight guidance. System enhancements are available, or will be made available on most of the concerned aircraft to prevent the inappropriate combination of the two functions.

The role of the pilot monitoring is especially important to support the pilot flying in detecting when an inappropriate reversion to V/S or FPA mode occurs. The warning to listen and look for are the triple-click (except on A300-600 and A310 aircraft), FD flashing, and guidance mode boxing on the FMA. These cues get the attention of the flight crew who can check the reversion parameters and take action if needed.

To “understand the FMA at all times” and “take action if things do not go as expected” are two of the Airbus Golden Rules for Pilots that are very relevant to avoid the effects of inappropriate V/S target during autoflight mode reversion.

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Safety first

The Airbus Safety magazine

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