

Safe Handling of TCAS Alerts



TCAS RAs are not correctly followed in more than 40% of cases according to a recent study published by Eurocontrol, making non-compliance with TCAS RAs one of the top 5 Air Traffic Management (ATM) operational and safety risks.

This article explains how the TCAS Alert Prevention (TCAP) and AP/FD TCAS functions can improve the situation by respectively reducing the number of RAs in congested airspace, and assisting flight crews to follow TCAS RAs in an optimum manner. The article also recalls the TCAS warning procedure step-by-step, with and without the AP/FD TCAS function and provides guidance for training flight crews.

This article is also available on safetyfirst.airbus.com and on the Safety first app for iOS and Android devices.



TCAS ALERTS IN OPERATIONS

Flight crews reacted correctly to a TCAS Resolution Advisory (RA) in only 58.7% of cases according to a recent study published by Eurocontrol(*) in April 2021. In 29.8% of cases, the flight crew reacted by modifying the aircraft trajectory but did not reach the expected target. In 11.5% of cases, the flight crew did not react, or they reacted excessively and sometimes had the opposite reaction to what the RA requested.

Flight crews must always remember that a prompt and accurate response to TCAS RAs is important to maintain the highest level of safety.

(*) "The assessment of pilot compliance with TCAS RAs, TCAS mode selection, and serviceability using ATC radar data" issue 2.1 published on 09-APR-2021 by Eurocontrol.

The Eurocontrol study observed a **low level of compliance with "Climb" or "Descend" RAs**: only 33.7% of the "climb" and "descend" RAs were correctly followed, 44.2% did not reach the expected target, and 22.1% were not flown correctly.

“Only a third of the “climb” and “descend” RAs were correctly followed”

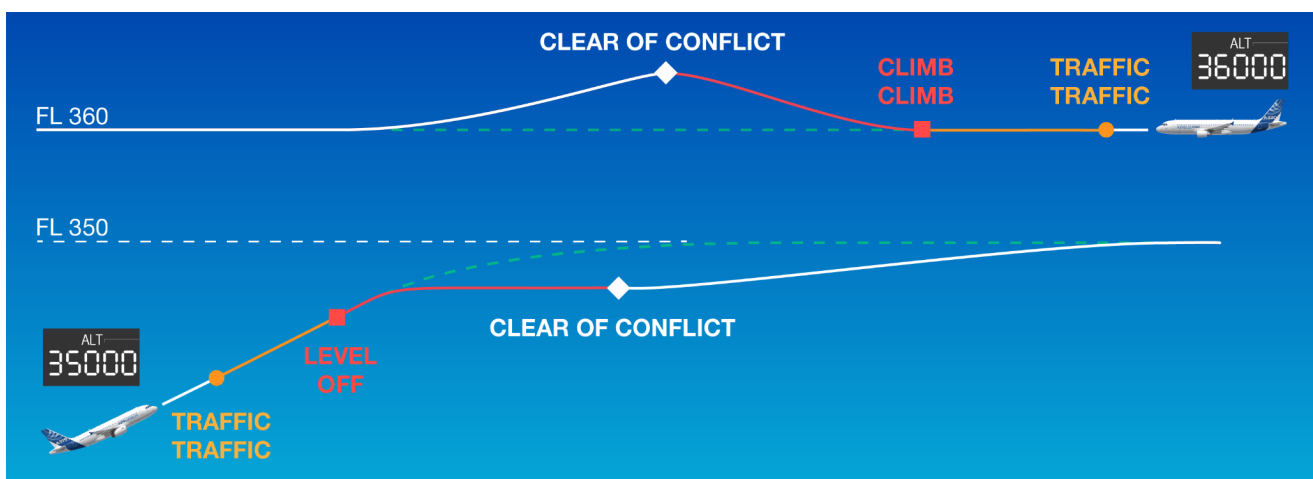


(fig.1) Flight crew response to TCAS RAs (data from the Eurocontrol study*)

Why "level off" RAs are triggered in congested airspace?

The TCAS warning logic uses the current trajectory of the aircraft to predict collision threats. This does not anticipate the expected level off when the aircraft finishes its climb or descent and reaches its expected flight level. If another aircraft approaches on an adjacent flight level, it can trigger a "level off" RA, or a "level off" with a corresponding "climb" or "descend" RA (fig.2). This is more likely to occur in congested airspace.

(fig.2) Example of an RA triggered when reaching a cleared flight level, near an aircraft flying on an adjacent flight level



“Level off” RAs made up 65% of all observed RAs in the Eurocontrol Study. ICAO recommends that the flight crew manually select a lower vertical speed when approaching the target flight level to prevent the triggering of “level off” RAs. This solution is effective but not always optimal, because it requires intervention by the flight crew. This is why Airbus developed the **TCAS Alert Prevention (TCAP)** function. ■

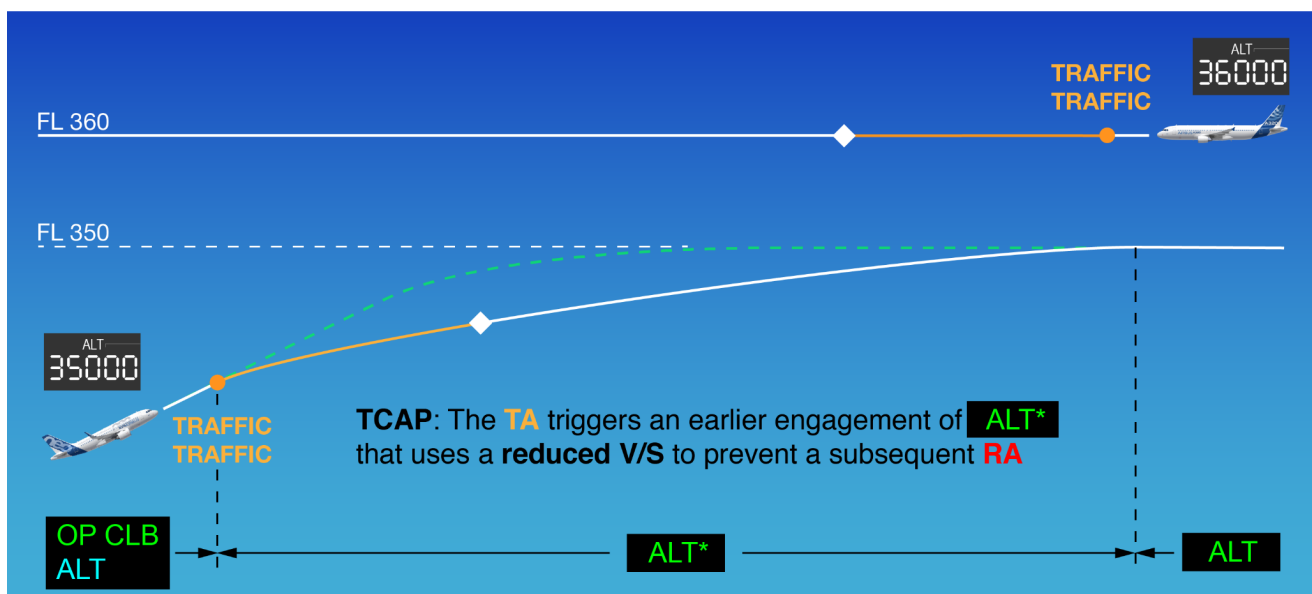
“Level off” RAs made up 65% of all observed RAs in the Eurocontrol Study.”

TCAP PREVENTS RAs

The TCAP function is an improved **ALT*** altitude capture law for flight guidance computers. When a TCAS Traffic Advisory (TA) is triggered for an aircraft that is almost at its target flight level, the **ALT*** guidance mode will engage earlier and use a reduced vertical speed to reach the target altitude. This will prevent the need for an RA (fig.3). If the **ALT*** guidance mode is already engaged when the TA is triggered, the TCAP function will further reduce the **ALT*** vertical speed to prevent the RA.

If an Operator has a mixed fleet configuration of aircraft with and without the TCAP function activated, the flight crew can still manually select a lower vertical speed when approaching the target flight level on any aircraft depending on the Operator's policy. ■

(fig.3) Principle of the TCAP function



TCAP Availability

The TCAP function is installed on A350 aircraft and on A380 aircraft delivered since July 2013. TCAP is also installed on all A320 family aircraft produced since early 2021, and on all A330 aircraft produced since October 2017 (since February 2016 on A330 aircraft with RR engines).

A380 aircraft delivered before July 2013 can be retrofitted using the activation Service Bulletin (SB) A380-22-8011.

Operators can retrofit TCAP on older A320 family and A330 aircraft. These aircraft must be fitted with a minimum standard of TCAS and a minimum standard of FMG(E)C. The minimum TCAS computer standard must be:

- ACSS **TCAS 2000** Change 7.0, or
- ACSS **T2CAS Std 1**, or
- ACSS **T3CAS Std 1**, or
- Collins **TCAS TTR920** Change 7.0, or
- Honeywell **TCAS TPA81A** Change 7.0.

On **A320 family aircraft**, the TCAP function is automatically activated on aircraft equipped with the following:

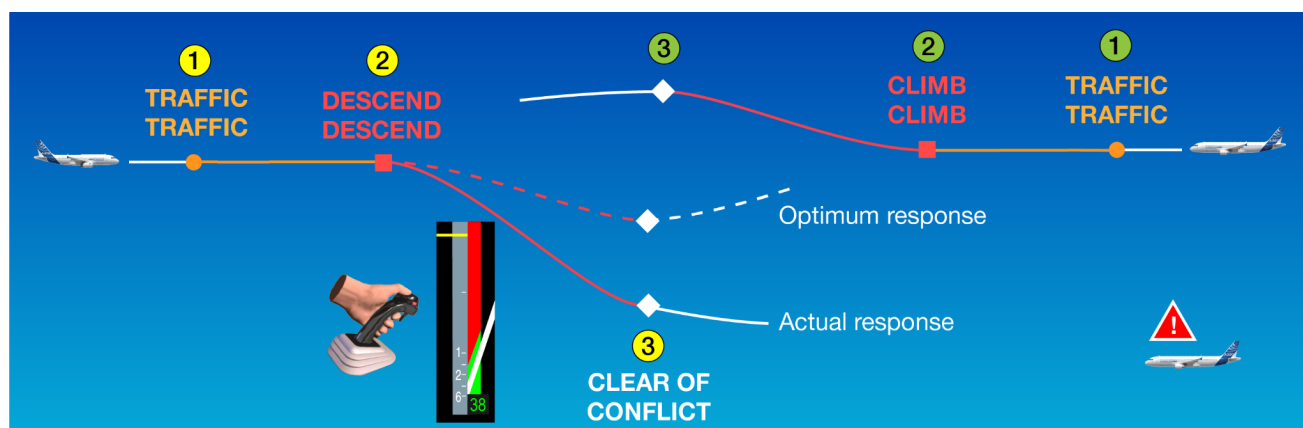
- An FMGC with flight guidance Standard **PI17**, **PC20** or a subsequent standard
- Wiring installed by Mod 38790 (+Mod 30248 if T2CAS) between the FMGC and the TCAS/T2CAS/T3CAS computer.

On **A330 aircraft**, an activation service bulletin is necessary in addition to installing an FMGEC with flight guidance standard **HJ2** or **H3**.

AP/FD TCAS ENSURES AN OPTIMUM HANDLING OF THE TCAS RAs

Sometimes the flight crew does not comply with RAs as expected or performs a maneuver that is too weak or excessive (**fig.4**). To help the flight crew perform optimum maneuvers in accordance with the RA, Airbus developed the AP/FD TCAS function.

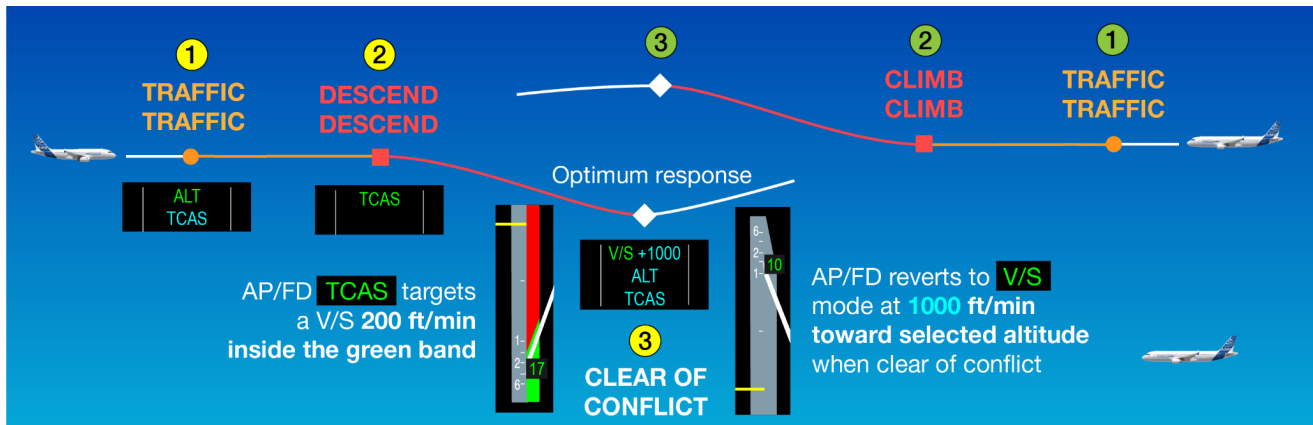
(fig.4) Response to TCAS RAs are not always optimum



AP/FD TCAS enables the flight crew to follow TCAS RAs with AP ON or FD guidance

The AP/FD TCAS function is an additional flight guidance mode of the autoflight system available for A320, A330, A350 and A380 aircraft. This function enables flight crews to either keep the autopilot ON to automatically follow the RA, or to manually perform the RA maneuver using FD guidance (fig.5): ① When a TA is triggered, the **TCAS** mode is armed. ② When an RA is triggered, the **TCAS** mode is engaged and targets a vertical speed **200 ft/min inside the RA green band**. ③ When the aircraft is clear of conflict, the TCAS mode then reverts to a **V/S +/-1000** vertical speed mode toward the initially selected altitude.

(fig.5) AP/FD TCAS ensures optimum handling of the TCAS RAs



The AP/FD TCAS function assists flight crews to:

- Correctly respond to the RA and in a timely manner
- Perform a maneuver only to the extent necessary
- Perform a maneuver with a moderate load factor to ensure passenger comfort and to reduce the risk of injury.
- Prevent the triggering of TCAS alerts on other aircraft.

Possible reversion to the standard procedure

If the flight crew prefers to follow the RA using the standard TCAS warning procedure, they can revert to it at any time. However, an Airbus analysis of more than 130 000 flights performed by A350 and A380 aircraft confirms the confidence of flight crews in the AP/FD TCAS function: in 91% of the RA situations, the flight crew kept the autopilot ON.

“If the flight crew prefers to follow the RA using the standard TCAS warning procedure, they can revert to it at any time.”



AP/FD TCAS Availability

AP/FD TCAS is installed on all A350 and A380 aircraft. The function is installed by default on all A320 family aircraft produced since February 2017, and on all A330 aircraft produced since April 2012.

The AP/FD TCAS can be installed on A320 family and A330 aircraft that comply with the minimum system prerequisites listed below:

Minimum system prerequisites for A320 family aircraft

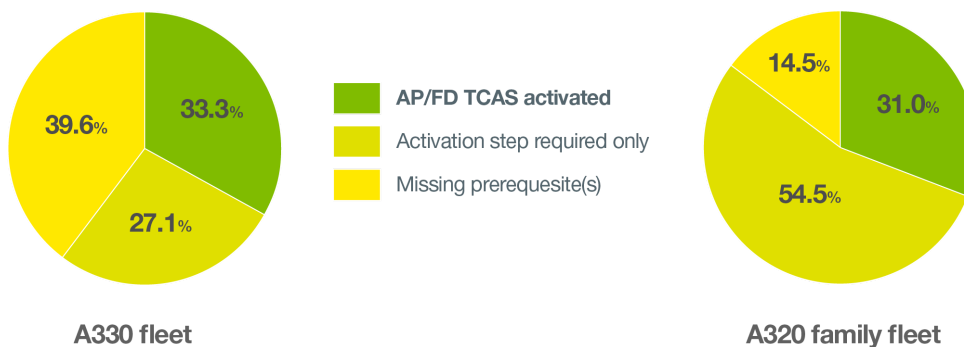
FMGC H2C13 or S6C13 or H2BPC13 or S7PC13 for aircraft fitted with CFM engines	MOD 152224 or MOD 152225 or MOD 154191 or MOD 155031
FMGC H2I12 or S6I12 or H2BPI12 or S7PI12 for aircraft fitted with IAE/PW engines	MOD 152967 or MOD 152968 or MOD 154192 or MOD 155032
FWC H2F5	MOD 37871
EIS: EIS2 S8-2 or EIS1 V70	MOD 38146 or MOD 150603
TCAS change 7 or T2CAS or T3CAS	MOD 27740 or 27698 or 36559 or 34637 or 39146
FDIMU with new FDIU Standard S15	MOD 150037 or MOD 150038
FCU standard 4	MOD 38132
Wiring provisions	MOD 38790

Minimum system prerequisites for A330 aircraft

FMGEC P4H3 or P5H3 or P5H3 or T5AH3	MOD 205773 or MOD 204758 or MOD 207492 or MOD 204775
FWC T3	MOD 58751
EIS: EIS2 L7 or EIS1 V513	MOD 57115 or MOD 201332
TCAS Change 7.0 or T2CAS or T3CAS	MOD 47392 or 52992 or 58449 or 46986 or 47572 or MOD 46728
FDIMU Standard L10 (Only if in EIS1 V513 configuration. Not necessary for EIS1 V514)	MOD 58688
FCU Standard 3	MOD 200272
Wiring provisions	MOD 57112 and MOD 56759 and (MOD 200939 (for TCAS) or MOD 201160 (for T2CAS or T3CAS))

Many in-service aircraft have all prerequisites for activation of AP/FD TCAS

An analysis of the in-service fleet shows that only slightly more than 30% of A320 family and A330 aircraft have the AP/FD TCAS function activated. The analysis also shows that a number of A320 family and A330 aircraft have all the system prerequisites installed and only need to activate the function to be able to use it. Operators should contact their Airbus Customer Support Director for information on the service bulletin about activating the AP/FD TCAS function on A320 family and A330 aircraft.



(fig.5) AP/FD TCAS installation status for A320 family and A330 aircraft

AP/FD TCAS: Mixed Fleet is not an Issue

Despite the possibility of retrofitting the AP/FD TCAS function on in-service A320 and A330 aircraft, some Operators may not be able to equip a full fleet with AP/FD TCAS. This should not stop Operators from activating the function on their capable aircraft, because operations with a mixed fleet are possible.

When operating a mixed fleet, flight crews can easily check the **Aircraft Configuration Summary (ACS) table** in the QRH during cockpit preparation. This will tell them if the aircraft has the AP/FD TCAS function activated.

In addition, flight crews must know how to apply both TCAS warning procedures (with and without AP/FD TCAS function), because even with the AP/FD TCAS activated, they will need to apply the standard TCAS warning procedure if the AP/FD TCAS function is inoperative.

Both procedures are described in the FCOM and QRH Memory Items part [MEM] SURV / TCAS WARNING.

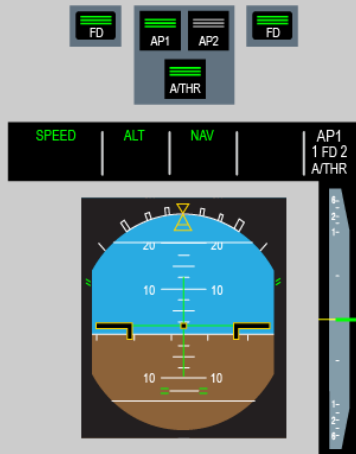
Step 1: If a TA is triggered, select the appropriate procedure to apply

- If **TCAS** is **NOT displayed** on the FMA, it is **not available or not installed**. If a TA is triggered, the PF announces **"TCAS, I have control"** and must be prepared to apply the standard TCAS warning procedure.
- If **TCAS** is **displayed** as armed on the FMA, the flight crew can use the AP/FD TCAS function in automatic or manual flight. In this case, the PF announces **"TCAS blue"**, ensures that the autothrust is engaged, and prepares to either fly the potential RA maneuver using autopilot or manually fly the RA with FD guidance.

“When operating a mixed fleet, flight crews can easily check the Aircraft Configuration Summary (ACS) table in the QRH during cockpit preparation.”

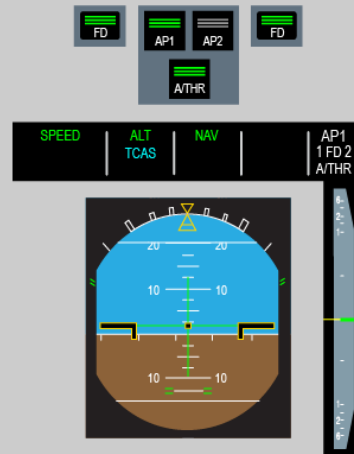
Step 1: "TRAFFIC TRAFFIC"

If AP/FD TCAS is NOT available



PF calls "TCAS, I have control"

If AP/FD TCAS is available



PF calls "TCAS blue"

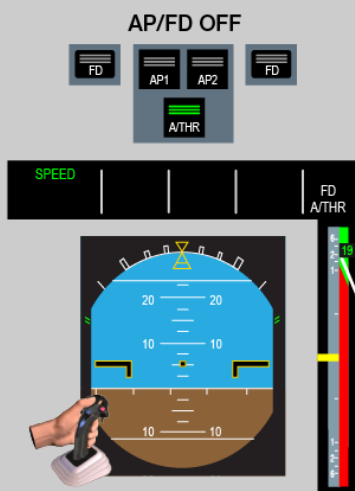
Step 2: Use the appropriate level of automation to follow the RA

Depending on the availability of the **TCAS** mode, the PF follows the RA with the appropriate level of automation:

- If the **TCAS** mode is not available or does not engage when the RA is triggered, the PF disconnects both the AP and the FD and flies the green on the V/S scale as per the standard TCAS warning procedure.
- If the **TCAS** mode engages when the RA is triggered, the PF can either leave the AP ON and monitor that the V/S reaches the green zone on the PFD, or manually follow the RA using FD guidance. The FD bars will automatically appear when the TCAS mode engages if they were previously switched off.

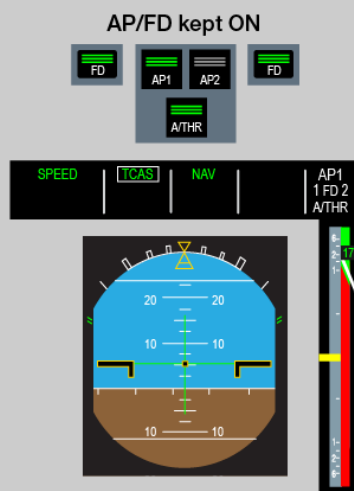
Step 2: "CLIMB CLIMB"

If AP/FD TCAS is NOT available

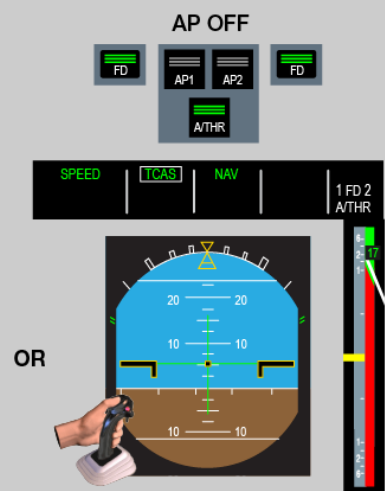


PF flies the green

If AP/FD TCAS is available



PF calls "TCAS" & monitors V/S inside the green



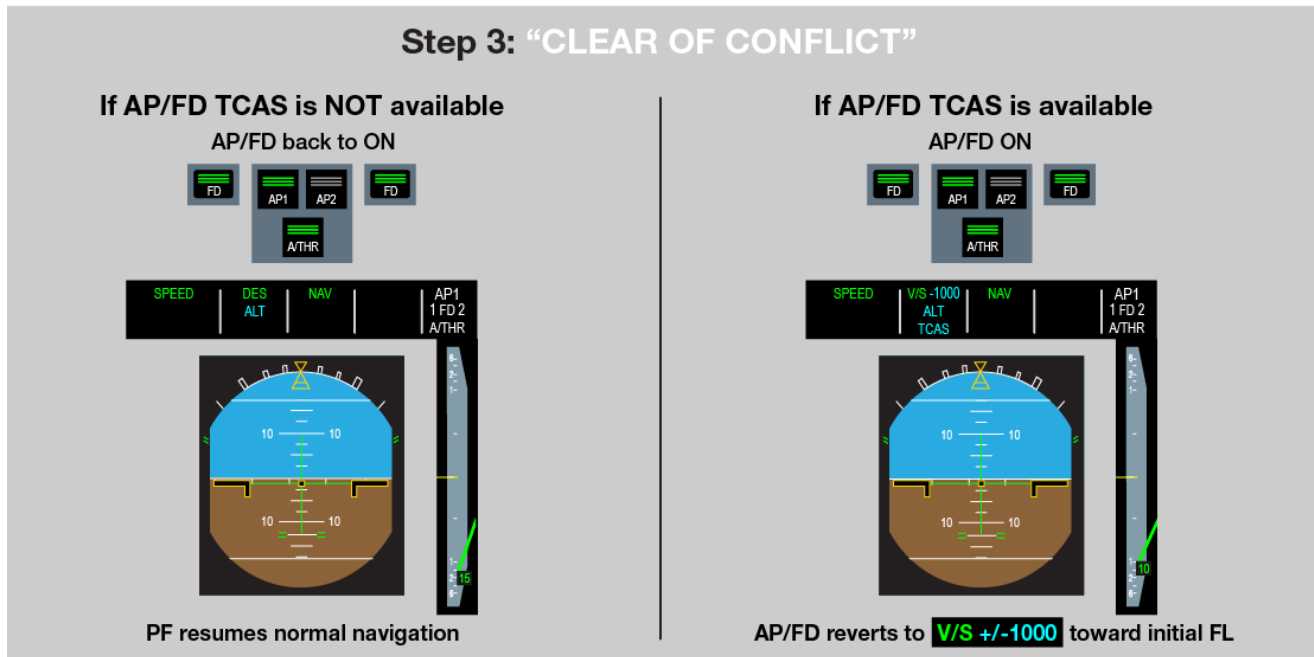
OR

PF calls "TCAS" & follows FD to fly the green

Step 3: Return to the initial trajectory when clear of conflict

When the aircraft is clear of conflict:

- If the RA was flown manually, the PF may adjust both the lateral and vertical trajectory to resume normal navigation in accordance with ATC instructions and may re-engage the AP and FD.
- If the RA was flown in **TCAS** mode, the flight guidance reverts to **V/S +/-1000** mode when clear of conflict to go back to the selected altitude. The PF should then engage an appropriate vertical mode, or adjust the V/S target, in accordance with ATC instructions.



INFORMATION

The "[Operational use of the TCAS](#)" video available on the Worldwide Instructor News (WIN) website provides detailed information about the TCAS and how to use it. The video also describes the AP/FD TCAS function and provides answers to frequently asked questions.

The "Getting to Grips with Surveillance" brochure issue 2 also provides information about the TCAS and is available for download on the AirbusWorld portal.

Refer also to our first Safety first article on AP/FD TCAS published in February 2009: "[Airbus AP/FD TCAS mode: a new step towards safety Improvement](#)".

Training on TCAS Warning Procedures

The Airbus Flight Crew Training Standards (FCTS) manuals provide recommendations for both type rating and recurrent training programs on how to train flight crews to apply the TCAS procedures. The manuals contain recommendations to define the training objectives in line with ICAO (doc 9995 Manual of Evidence-Based Training) and IATA recommendations (Evidence-Based Training Implementation Guide). FCTS manuals are available for download from the AirbusWorld portal.

During the type rating and recurrent training courses, flight crews should be trained on how to apply the TCAS procedure both with and without the AP/FD TCAS function. This is to ensure that the flight crew will react correctly to a TCAS warning if the AP/FD TCAS function is not available or if it is inoperative on their aircraft.

Evidence-Based Training (EBT) programs recommend that the TCAS procedure training should be performed at least one time every three years. ■

“flight crews should be trained on how to apply the TCAS procedure both with and without the AP/FD TCAS function.”



INFORMATION

Upcoming modification (May 2022) of the TCAS Warning procedure in approach:

The TCAS WARNING procedure will be updated in May 2022 to standardize the procedure on all Airbus aircraft (all aircraft types, with or without AP/FD TCAS) and to comply with EASA and FAA regulation requirements. The procedure will be amended as follows:

- If any “CLIMB” audio indicator sounds during the final approach:

GO AROUND.....PERFORM.

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It is crucial that flight crews respond promptly and accurately to TCAS Resolution Advisories (RAs) to maintain the highest levels of safety. However, TCAS RAs are not always followed as expected in operations according to a study published by Eurocontrol in April 2021. This confirms why non-compliance with TCAS RAs is identified as one of the current top-5 ATM operational risks.

The TCAP function can improve the situation by preventing RAs in congested airspace. The AP/FD TCAS function can provide assistance to the flight crew for following the TCAS RAs in an optimum way.

The TCAP and AP/FD TCAS functions are now activated on all newly built aircraft. Many A320 family and A330 in-service aircraft have all the system prerequisites and can easily activate the AP/FD TCAS function. Airbus encourages Operators to contact their Customer Support Directors for details on how to implement AP/FD TCAS on their aircraft and benefit from this function.

Flight crews can identify if an aircraft is equipped with the AP/FD TCAS function by checking the Aircraft Configuration Summary table in the QRH. In addition, the flight crew will know if the AP/FD TCAS function is available when the **TCAS** guidance mode is displayed as armed on the FMA in the case of a TA. Flying a mixed fleet of aircraft with or without the AP/FD TCAS function is therefore not an issue.

During type rating and recurrent training, flight crews should be trained on how to apply both TCAS warning procedures, with and without the AP/FD TCAS function, so that they can apply the standard TCAS procedure if the AP/FD TCAS function is not available.

Evidence-Based Training programs recommend training flight crews on how to apply the TCAS warning procedures at least one time every three years.

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