SAFETY FLASH

ACAS II bulletin No 9

EUROCONTROL

Frequently Asked Questions

Editorial

EUROCONTROL decided to publish the ACAS Bulletins, after a number of significant issues were identified during ACAS operational monitoring. Many of these have been addressed in detail in the previous ACAS Bulletins.

However, the Mode S and ACAS Programme receives many questions on other TCAS II operational topics which have not yet been covered. This edition of the Bulletin provides answers to some frequently asked questions on the subjects of:

- *TCAS II operations on the ground*
- *RA display to controllers*
- *Interaction with military operations*
- *"Descend" RAs at low altitudes*
- *Operations in degraded situations*
- *"Nuisance" RAs*

Understanding TCAS II operation, and applying TCAS 'best practice' will help to maximise the safety benefit of TCAS II.

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Should TCAS be operated on the ground?

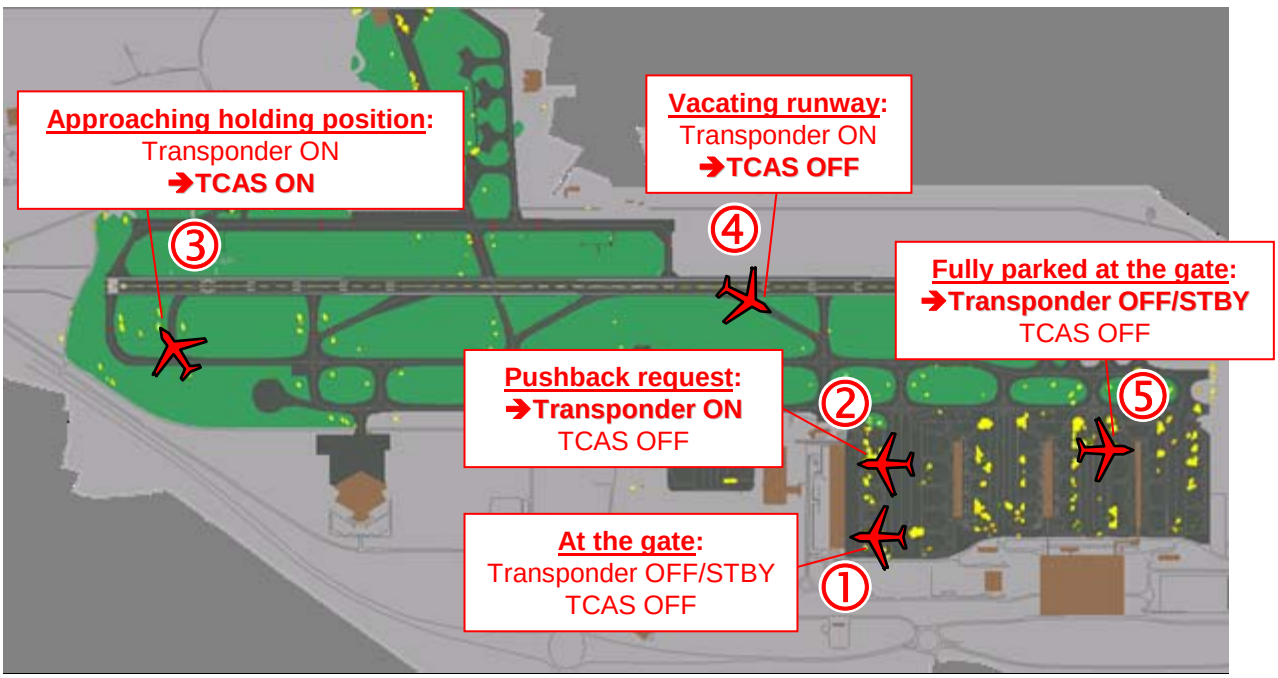
The Advanced Surface Movement Guidance and Control System (A-SMGCS) is to be introduced at a number of European airports. To enable A-SMGCS detection, aircraft must be operating their Mode S transponders, at least from the pushback and until reaching the stand on arrival.

TCAS also relies on Mode S technology and for this reason TCAS and Mode S control panels are usually combined in a single unit on the flight deck.

Experience shows that TCAS is sometimes turned 'on' and turned 'off' at the same time as the Mode S transponder. Except for turning TCAS on for a short period of time before crossing an active runway to double-check for the presence of any aircraft on approach, this should not be done for the following reasons:

- **TCAS II is not designed to provide any safety benefits for aircraft on the ground:** the collision avoidance function is not active before being airborne and the TCAS traffic display does not depict intruders detected on the ground (Note: due to erroneous transponder data, some aircraft on the ground may be displayed).
- **TCAS II routine operation on the ground degrades safety**. Performances of the ground surveillance equipment (e.g. SSR, A-SMGCS) and of the surveillance by airborne TCAS II units can be compromised if there are significant numbers of TCAS II units operated on the ground. As a result, ATC and the operation of airborne TCAS II could be adversely affected. (For more details, refer to www.eurocontrol.int/msa).

To address these issues, ICAO recommends in PANS-OPS (Doc 8168) and the ACAS manual (Doc 9863) not to operate TCAS II while taxiing.



Can RAs be displayed to controllers?

Although the ACAS procedure defined in ICAO PANS-OPS, Doc 8168, reinforces the need for pilots to notify RAs to the controller as soon as permitted by flight crew workload, operational experience shows that controllers are often given very late or incomplete information about an RA or, indeed, that they are not informed at all.

In an effort to rectify this problem, EUROCONTROL investigated the feasibility of providing RA information on controllers' displays.

When an RA is generated on-board an aircraft, the transponder automatically downlinks detailed information about the RA and the intruder to ground-based ATC equipment through Mode S communications. The investigation centred on adapting this information for presentation onto the controllers' screens and assessing the operational utility of such information.

While the results point to operational benefits, the study has identified some areas of concern that need further investigation. Information and results of EUROCONTROL studies and simulations on RA Downlink can be found on: www.eurocontrol.int/ra-downlink.

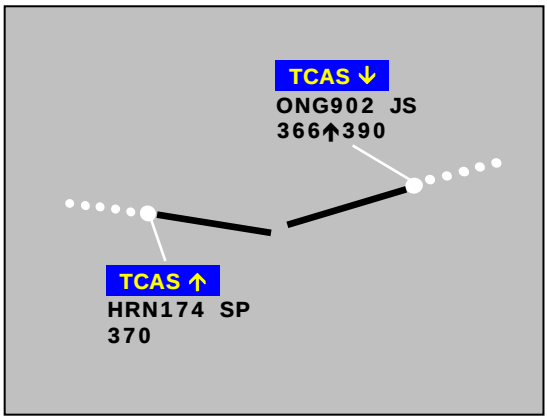


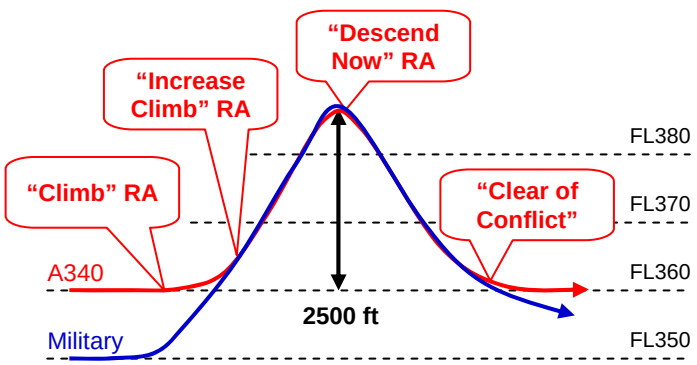
Illustration of one of possible RA display on the controller's screen

Can military operations interact with TCAS II?

Event 1: Interception of civil aircraft

An A340, level at FL360, has passed through several sectors without contacting ATC. As several attempts to contact the aircraft failed, the instruction is made to intercept the A340. However, **the interceptor is instructed not to switch off its altitude report**. Consequently, when the interceptor approaches the A340, the A340 TCAS triggers a "Climb" RA.

The pilot of the A340 begins to climb and at this point contacts ATC to report the RA. However, he does not reply to several calls from the interceptor on 121.5 MHz. Consequently, the military aircraft continues to follow the A340, inducing an "Increase Climb" RA. When reaching FL385, the A340 pilot reports that the minimum selectable speed has been reached and that he has to descend back to avoid stalling. This manoeuvre induces a reversal "Descend Now" RA. The duration of RAs was 4 minutes.



As a reaction to an RA during an interception may be misinterpreted by the military pilot as an escape manoeuvre, it is important that the recommended procedure for interception is followed.

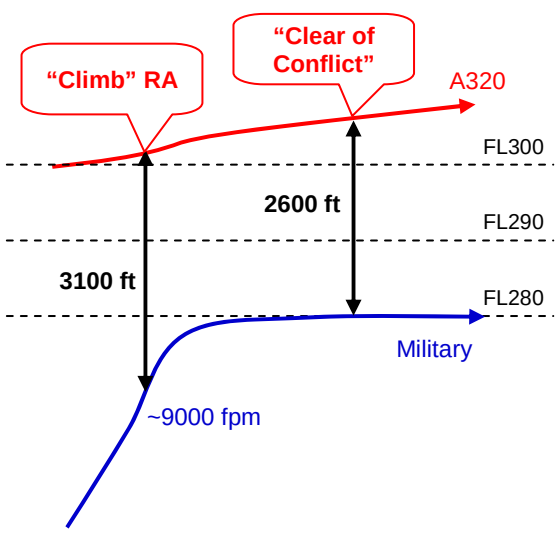
In Doc 9433, ICAO recommends that "***the interceptor suppresses the transmission of pressure-altitude information in its SSR transponder replies within a range of at least 20 NM […] of the aircraft being intercepted***". It explains that "*this prevents the ACAS in the intercepted aircraft from using resolution advisories in respect of the interceptor*". This recommendation was repeated in State Letter SL01-114, dated 29 November 2001.

Event 2: High vertical rate

An A320 is climbing to FL350 at 700 fpm, under the control of sector.

A military aircraft is below and climbing at about 9000 fpm, under military control. Both aircraft are converging towards the same point (the minimum distance is 0.9 NM).

Because the military aircraft is climbing with a high vertical rate, the A320 TCAS II triggers a "Climb" RA when the military aircraft is still 3100 ft below. Shortly after, the military aircraft levels-off at FL280.



The vertical separation between the aircraft was never less than 2500 ft during the event.

This illustrates that **even when the vertical separation between two aircraft is significantly greater than the ATC separation minima, RAs can be triggered due to high vertical rates**. Such RAs are especially likely to be triggered by military aircraft because of their performance capabilities.

Event 3: Necessary "Descend" RA at low altitude

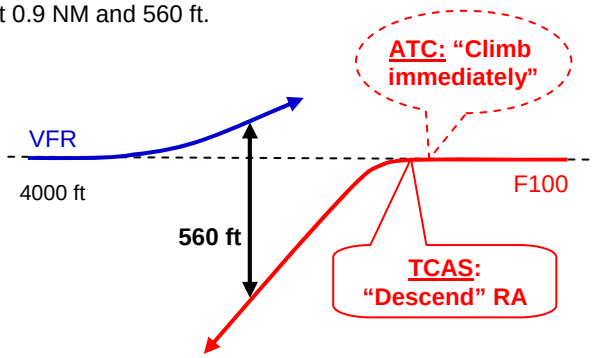
A Fokker 100 (F100) on approach in class D airspace is level at 4000 ft QNH on a track to intercept the ILS localizer and is in contact with the approach controller. On the opposite track, a VFR traffic, non TCAS equipped, is also level at 4000 ft QNH and is in contact with another controller. There has been no coordination between the two controllers.

When the approach controller detects the conflict, he instructs the F100 to immediately climb back to 5000 ft. However, the TCAS of the F100 triggers a "Descend" RA just after the ATC instruction to climb. In compliance with the ICAO regulation the pilot follows the RA and disregards the opposite ATC instruction. Additionally, the VFR pilot initiates a climb and makes a 90° turn that increases the horizontal miss distance.

As a result, the aircraft passed at 0.9 NM and 560 ft.

If the F100 pilot had followed the ATC instruction, it would have crossed the VFR aircraft trajectory and the vertical distance would have been less than 300ft.

TCAS II is also very effective at low altitudes. "Descend RAs" at low altitudes must be followed as any other RA.



TCAS RA progressive inhibition

TCAS II progressively inhibits RAs depending on the height Above Ground Level (AGL) provided by the radio altimeter:

- *"Increase Descent" RAs are inhibited below 1,550 ft AGL*
- *"Descend" RAs are inhibited below 1,100 ft AGL*
- *All RAs are inhibited below 1,000 ft AGL*

The above values are ± 100 ft and the exact values depend on the aircraft attitude.

If, despite these inhibitions, there are simultaneously a TCAS RA and GPWS/wind shear/stall alerts, these have priority over TCAS which is automatically switched to the TA-only mode.

What to do in case of degraded performance?

TCAS II failure

- **Flying with an inoperative TCAS II is permitted, including in RVSM airspace, provided it is done in accordance with the applicable MEL**. In the ECAC States, the period for which the alleviation is granted is 10 consecutive days (in accordance with JAR-OPS 1 TCAS II MEL) except for operations in German airspace, which are subject to a **3 day** MEL period.
- ATC authorities are not required to determine whether an aircraft is fitted with TCAS II, nor is it the role of ATC to police the TCAS II serviceability.

  "*The procedures to be applied for the provision of air traffic services to aircraft equipped with ACAS shall be identical to those applicable to non-ACAS equipped aircraft*" (ICAO PANS-ATM, Doc 4444).

  Consequently, there is **no requirement to annotate in the flight plan that TCAS II is unserviceable**.
- **An aircraft that has a TCAS failure during flight, can continue to its destination**. There is no requirement to declare TCAS II failure to ATC. At destination, the appropriate MEL regulation applies.
- **As long as the transponder of an aircraft with an unserviceable TCAS II continues to report altitude, it will be visible to other aircraft operating TCAS II.**

Other failures

➔ **Other equipment failure or switched off**

TCAS II can only function if the associated equipment (e.g. transponder, radio altimeter, altitude source) is also functioning. If one of these fails or is switched off, TCAS II will be inoperative as a consequence.

➔ **Other aircraft Mode C failure**

TCAS II cannot issue any RAs against aircraft which do not report their altitude; as a result, the TCAS safety net is disabled. Consequently, pilots must not turn off altitude reporting, unless required by ATC after it has been established that the reported altitudes are incorrect.

Degraded performance

TCAS II provides maximum benefits when operated in RA mode and when all RAs are followed promptly and accurately. However, when the aircraft performance is degraded (e.g. an engine failure, an emergency descent, etc.), it might not be possible to comply with a "Climb" RA.

Therefore, **airlines must define clear procedures** to address degraded aircraft performance situations, having in mind that:

- When operated in RA mode, non-compliance with an RA will adversely affect the efficiency of the coordinated RA triggered on-board the other aircraft.
- When operated in TA-only mode, collision avoidance is still maintained by the TCAS II of the other aircraft

The use of the TA-only mode is described in the following note that will be included in the next version of the ICAO PANS-OPS, Doc 8168, due in November 2007:

"*Note 2. - The normal operating mode of ACAS is TA/RA. The TA-only mode of operation is used in certain aircraft performance limiting conditions caused by in-flight failures or as otherwise promulgated by the appropriate authority*."

Did you know that…? Some figures about TCAS II

5 The **factor of collision risk reduction thanks to TCAS II in the operational world**, taking into account some non TCAS II equipped aircraft, inaccurate pilot responses and lack of responses, altitude reporting inaccuracies, etc.

7.0 **Current version of TCAS II**. Version 7.0 is the only available equipment that is fully compliant with the ICAO Airborne Collision Avoidance System (ACAS) standards.

7.1 The reference of **the new TCAS II version,** which is currently under development. It will include an improvement of the reversal RA logic and, possibly, a modification of the RA list.

10 The number of **calendar days** during which a flight with inoperative TCAS II is permitted to operate by the JAR-OPS-1 ACAS MEL. Some countries have stricter MEL requirements.

14 The number of TCAS II **aural messages**, including "Traffic, Traffic" and "Clear of Conflict"

50 The measured **ratio between the number of Traffic Advisories and Resolution Advisories**

80 The **theoretical factor of collision risk reduction provided by TCAS II** assuming: all aircraft equipped with TCAS II, accurate pilot responses, perfect altitude reporting, etc.

300 The **vertical miss distance (in feet) targeted by TCAS II** at low altitudes. Above 20000 ft, TCAS II objective is 600 ft.

1000 The average number of **flight hours** between RAs on short and medium haul aircraft. The number increases to 3000 hours for long haul aircraft.

1500 The **vertical speed (in fpm) required by the "Climb" and "Descend" RAs**. If TCAS subsequently assesses that the RA has to be strengthened, an "Increase Climb" or "Increase Descent" RA will require 2500 fpm.

Are some RAs just a nuisance and unnecessary?

RAs are always necessary

Sometimes controllers complain about RAs that are issued to aircraft that they deem to be separated and ask why TCAS cannot have knowledge of ATC clearances to avoid these supposedly "nuisance" RAs.

***TCAS II is a last resort safety net and must work independently of data from the aircraft navigation or auto flight systems**. Therefore, in the assessment of threats, it does not take into account the ATC clearances, pilot's intentions or autopilot inputs, because these actions are subject to error, misunderstanding, and failure - as can be witnessed, for example, by the reported number of level busts.*

As reported in ACAS Bulletin n°2, some level busts occur even when the cleared flight level was correctly selected. Had TCAS taken the ATC clearances into consideration, the necessary RAs would not have been generated in time.

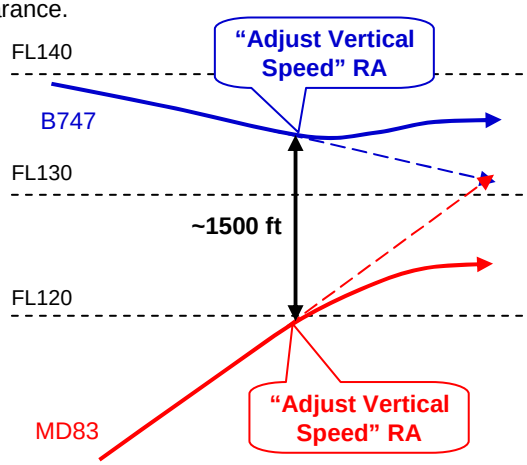
*Notwithstanding ATC clearances, TCAS II triggers an RA when it predicts that a risk of collision exists if the aircraft continue on the same trajectories. Therefore, although it might appear as a nuisance in hindsight, **an RA is always necessary at the time when it is generated**.*

Event 4: RAs between aircraft separated by ATC

A B747 is descending to FL130 at 500 fpm and a MD83 is climbing to FL120 at 2500 fpm on routes that are converging. Both flight crews have correctly read back their respective clearance.

As the MD83 approaches FL120, it receives an "Adjust Vertical Speed" RA that requires a reduction in the climb rate.

A coordinated "Adjust Vertical Speed" RA is triggered simultaneously on-board the B747 requiring a reduction in the descent rate (to which the pilot overreacted, initiating a 300 fpm climb).



In this event, the controller provided correct clearances that were correctly read back by the pilots and the RAs were generated while the vertical distance between the two aircraft was still greater than the 1000 ft vertical separation minimum. At this point, some might deem that the RAs were not necessary.

However, **the RAs were in fact necessary** as the MD83 actually went through its cleared altitude and the pilot only stopped the climb in response to the RA.

Had TCAS not generated the coordinated RAs, the trajectories of the two aircraft could have resulted in a mid-air collision 30 seconds later.

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