

WHAT YOU SEE ON A TCAS TRAFFIC DISPLAY IS NOT ALWAYS WHAT YOU WILL GET

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Ever since Wilbur Wright said to his brother Orville "let's build another one", the possibility of a collision between two aircraft has been a reality...

In the early days of aviation the separation between aircraft was solely achieved by visual means (see-and-avoid). The pilot looked outside in order to detect any hazards (principally other aircraft) and if a threat was detected, they would then undertake an avoidance manoeuvre. Today, pilots still scan the airspace around their aircraft not only when wholly responsible for their own separation but also when separation is provided by air traffic control and see-and-avoid is still applied successfully on countless occasions every day. Admittedly, at the speeds flown by commercial jets the chances of a successful avoidance manoeuvre as a result of visual acquisition can be quite low.

With the introduction of TCAS in the early 1990s, pilots of aircraft equipped with it were given an additional tool which helps them to visually acquire other aircraft. Each TCAS installation comes with a traffic display which depicts the approximate position of nearby aircraft, relative to one's own aircraft. It indicates the relative horizontal position of other aircraft in the vicinity as well as their relative vertical position if they are equipped with altitude reporting transponders (Mode C or Mode S).





The primary purpose of the traffic display is to aid a flight crew in the visual acquisition and maintenance of situational awareness in respect of other aircraft. The secondary purpose is to provide a flight crew with confidence in proper system operation and to give them time to anticipate the possibility that they may need to manoeuvre their aircraft in response to a Resolution Advisory. Although, some implementation details vary, all TCAS II traffic displays follow the same principles described in the table below.

The TCAS traffic display has certain limitations. As TCAS bearing measurement is not very accurate,

the position of other aircraft can be off by as much as 30°, however, usually the error is not more than 5°. Due to surveillance errors the target symbol on the display may jump.

Pilots can select various ranges of the traffic display and also TCAS surveillance range may be automatically reduced to 5 NM in high density airspace. With a small maximum range selected, pilots may be more likely to see aircraft in their vicinity which do not also appear on their TCAS traffic display. Even if aircraft are detected by TCAS, they may not be displayed, since some installations limit the number of displayed targets or provide relative altitude filtering.

The reference for the TCAS traffic display is the aircraft's own position and, consequently, all targets on the traffic display are shown in relative motion. Combined with the lack of a speed vector on targets, this may make deducing an intruder trajectory problematic, especially if one's own aircraft is manoeuvring horizontally. Moreover, the pilot does not usually have any knowledge of the intent of other aircraft.

The two examples on the following page show how situational awareness acquired through the indications on the TCAS traffic display can provide a safety benefit but how they can also be a source of confusion and lead to a reduction in separation.

TCAS TRAFFIC DISPLAY SYMBOLOGY AND ASSOCIATED RESPONSES

Symbol	Type	Pilot action
◇ or □	Other traffic	Visual acquisition. Vertical speed reduction if traffic is at the level adjacent to the cleared level.
◆ or ♦	Proximate traffic: Aircraft within 6 NM and 1200 feet of own aircraft	Visual acquisition. Vertical speed reduction if traffic is at the level adjacent to the cleared level.
●	Traffic advisory (TA): Nominally generated 20-48 sec. before Closest Point of Approach (CPA)	Visual acquisition. Vertical speed reduction if traffic is at the level adjacent to the cleared level. Prepare for possible RA.
■	Resolution advisory (RA): Nominally generated 15-35 sec. before CPA	Follow the RA as indicated by changing or maintaining the vertical speed.
+04 ■	Vertical trend arrow and relative altitude will be shown next to each symbol (in the matching colour). The relative altitude is displayed in hundreds of feet, above the symbol if the intruder is above own aircraft and below the symbol in the opposite case.	

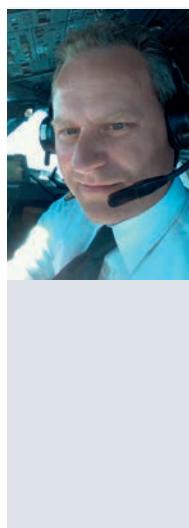
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Example 1

An Airbus 320 was on a departure with early left turn and an initial climb restriction of FL70. Due to the fact that there was a speed limit of 210 knots and the aircraft had a very light gross weight, the climb rate was high – more than 3000 ft/min. On checking in with the departure frequency, the crew got a clearance to continue the climb to FL90. At 5500 feet the crew received a TCAS TA and they could see descending traffic on their TCAS traffic display 3800 feet above in a 1 o'clock relative position, approximately 3 NM away. Assessing that this situation could lead to a 'nuisance' RA or even a conflict, the crew reduced their climb rate and levelled off at FL70, as originally cleared.

The pilot monitoring visually identified the conflicting traffic – an MD80 on an arrival downwind leg passing little more than 1000 feet above them. At this moment ATC called the A320 again "... confirm levelling off FL70?" The controller had inadvertently cleared the A320 to a higher level than he had intended.

By noting and interpreting the information on their TCAS display, the A320 crew was able to identify that the ATC clearance they had received might lead to an RA. Their response helped to prevent escalation of the situation, which could easily have initiated a chain reaction in dense traffic area close to a major airport.

Example 2

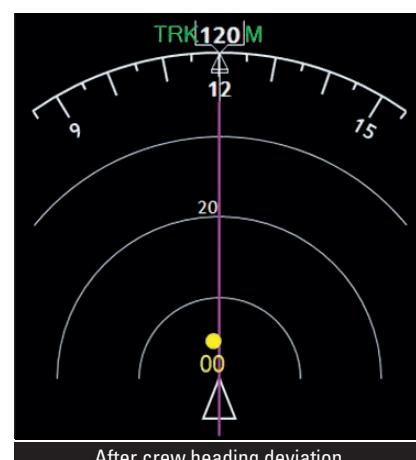
A classic example of incorrect use of the TCAS traffic display is a reaction of the B767 crew who observed another aircraft on their traffic display at the same altitude – an MD80 on a crossing track. The B767 was predicted to pass approximately 15 NM behind the MD80. Both aircraft were instructed by ATC to maintain their headings for separation. However, when the MD80 was 20 NM away, the B767 crew, decided (contrary to their ATC instruction) to turn right 20° to avoid the MD80. The B767 misinterpreted their traffic display and believed that the MD80 was coming from the opposite direction.

Following the right turn, the MD80 target remained on the left hand side on the B767 TCAS traffic display, still giving the impression that it was coming from the opposite direction. Subsequently, the B767 crew requested a descent clearance. The right turn had brought both aircraft closer together with the horizontal separation dropping to 2 NM at the closest point of approach. Both aircraft received TAs.

This case (fully described in ACAS Bulletin no. 6) clearly illustrates risks associated with using the TCAS traffic display for self-separation manoeuvres¹. It is a common misconception that turning away from a displayed intruder decreases separation, a phenomenon otherwise known as confusing increasing relative bearing with increasing separation.

Conclusions

Whilst the TCAS traffic display is useful in improving situational awareness, self-separation decisions taken based on traffic display information may lead to unintended outcomes. It is sometimes assumed that having display-based situational awareness will allow a pilot to take an appropriate decision which will eliminate a potential threat, but this is not necessarily the case. A perceived threat may in fact be no threat at all and manoeuvring may bring both aircraft closer. For this reason, it is strongly recommended that pilots do not normally manoeuvre their aircraft solely using TCAS traffic display indications. Of course manoeuvring based on visual acquisition may occasionally be justified and any indicated change in vertical speed annunciated as a TCAS Resolution Advisory must be followed. S



1- Other example of incorrect use of traffic display can be found in ACAS Bulletin no. 16 and no. 19)