**ETSO-C147a**
**Date: 19.12.2016**

# European Aviation Safety Agency

# European Technical Standard Order

**Subject:** Traffic Advisory System (TAS) Airborne Equipment

**1 - Applicability**

This ETSO gives the requirements that new models of active traffic advisory system (TAS) airborne equipment that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with applicable ETSO marking. Equipment Classes are:
- Class A. Equipment incorporating a horizontal situation display that indicates the presence and relative location of intruder aircraft, and an aural alert informing the crew of a Traffic Advisory (TA).
- Class B. Equipment incorporating an aural alert and a visual annunciation informing the crew of a TA.

**2 - Procedures**

2.1 - General
Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific
None.

**3 - Technical Conditions**

3.1 - Basic

3.1.1 - Minimum Performance Standard
Standards set forth in RTCA Document No. RTCA/DO-197A, 'Minimum Operational Performance Standards for An Active Traffic Alert and Collision Avoidance System I (ACTIVE TCAS 1),' Section Two (2) September 12, 1994, as amended by Appendix 1 of this document.

3.1.2 - Environmental Standard
See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 - Computer Software
See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Electronic Hardware Qualification
See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific
None

3.2.1 - Failure Condition Classification
See CS-ETSO, Subpart A, paragraph 2.4.
Failure of the function defined in paragraph 3.1.1 of this ETSO has been determined to be a major failure condition for malfunctions causing the display or annunciation of hazardously misleading information in airborne aircraft.
Loss of the function defined in paragraph 3.1.1 is a minor failure condition.

## 4 - Marking

4.1 - General
Marking is detailed in CS-ETSO Subpart A paragraph 1.2.

4.2 - Specific
None

## 5 - Availability of Referenced Document
See CS-ETSO Subpart A paragraph 3.

## APPENDIX 1.
## Changes to RTCA/DO-197A, "Minimum Operational Performance Standards for an Active Traffic Alert and Collision Avoidance System I (Active TCAS I)" applicable to Traffic Advisory System (TAS) airborne equipment.

*Note: This Appendix changes several sections of DO-197A that have been modified by DO-197A Change 1. However, the below changes adopt different requirements than those contained in DO-197A Change 1.*

### 1.0 Changes Applicable to Both Class A and Class B Equipment.

1.1 Receiver Characteristics.

1.1.1 **In-band Acceptance.** In lieu of paragraph 2.2.2.1 of RTCA DO-197A, substitute the following requirement:
Given a valid transponder reply signal in the absence of interference or overloads, the minimum trigger level (MTL) is defined as the input power level that results in a 90% ratio of decoded to received replies.
The MTL over the frequency range of 1,087 to 1,093 MHz shall be no greater than -70 dBm.

1.1.2 **In-band Acceptance.** In paragraph 2.4.2.2.1 of RTCA DO-197A, eliminate the following:
under Intruder Aircraft eliminate the last line: "Scenario C and D ≥ -78 dBm."
under Test Description Success:, eliminate the last sentence: "For scenarios C and D, the ratio of correctly decoded intruder replies to total input replies shall not exceed 10%."

1.2 **Transmission Frequency.** In lieu of paragraph 2.2.3.1 of RTCA/DO-197A, substitute the following requirement:
"The transmission frequency of Mode C interrogations shall be 1,030 ±0.2 MHz."

1.3 **Transmitter RF Output Power**. In lieu of paragraph 2.2.3.2 of RTCA/DO-197A, substitute the following requirement:
When transmitting at full (unattenuated) output power, the peak RF output power delivered to a quarter wave stub antenna shall be within the following limits:

- Maximum RF Power: 54 dBm (250W)
- Minimum RF Power: 50 dBm (100W)

In the event that antenna gain differs from that of a quarter wave stub antenna (3 dBi), the power limits shall be adjusted accordingly. These limits are based upon range and interference limiting requirements.

***Note: When transmitting at full (unattenuated) power, the RF power radiated at the pattern peak shall be within the following limits:***

- ***Maximum EIRP: 57 dBm (500W)***
- ***Minimum EIRP: 53 dBm (200W)***

***It is assumed that the peak gain of a typical quarter wave stub antenna is 3 dBi.***
***EIRP = Effective Isotropic Radiated Power.***
***Note: As an alternative to the above, an active TAS may choose to operate as a low power system at a fixed rate power product limit of 42 Watts per second, in which case the peak RF output power delivered to a quarter wave stub antenna shall not exceed 46 dBm (40W).***

1.4 **Transmitter Pulse Characteristics**. In lieu of paragraph 2.2.3.5 of RTCA/DO-197A, substitute the following requirement:
ATCRBS interrogations from active TAS shall employ the Mode C format illustrated in Figure 2-1.

The rise and decay times may be less than shown in the following table, provided the sideband radiation does not exceed the spectral limits tabulated in this standard. The amplitude of P3 shall be within 0.5 dB of the amplitude of P1.

ACTIVE TAS MODE PULSE SHAPES (All values in Microseconds)

| Pulse Designator | Pulse Duration | Duration Tolerance | Rise Time | | Decay Time | |
|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Max |
| P1, P3 | 0.8 | **+ 0.075** | 0.05 | 0.1 | 0.05 | 0.2 |

The pulse spacing tolerances shall be as follows:
P1 to P3: 21 ± 0.10 microseconds

1.5 **Mode S Broadcast Reception**. In lieu of paragraph 2.2.4.2 of RTCA/DO-197A, substitute the following requirement:
The Active TAS shall have the capability to receive 1,030 MHz Mode S broadcast signals for the purpose of obtaining a count of TCAS interrogators in its vicinity. Mode S reception may reside in an associated Mode S transponder, or may by integral to the Active TAS equipment, in which case those functions necessary to receive and process Mode S broadcast signals for a TCAS count shall be implemented and tested in accordance with RTCA/DO-181A.
*Note: As an alternative to the above, an active TAS may choose to operate at a fixed rate power product limit of 42W/sec, in which case the requirement to obtain a count of TCAS interrogators for the purpose of interference limiting is eliminated.*

1.6 **Interference Limiting**. In lieu of paragraph 2.2.6 of RTCA/DO-197A, substitute the following requirement:
To assure that all interference effects from Active TAS equipment are kept to a low level, Active TAS equipment shall control its interrogation rate or power or both to conform to the following limits. These limits are given in terms of:

RR = the Mode A/C reply rate of own transponder
NT = the number of airborne TCAS interrogators detected via Mode S broadcast receptions with a receiver threshold of -74 dBm.

The Minimum Active TCAS shall have the capability to monitor RR and NT and to use this information in interference limiting. Once each scan period, NT shall be updated as the number of distinct TCAS addresses received within the previous 20 second period.
The limits are as follows:

| NT | K<br>Upper Limit for $\Sigma P(k)$<br>k=1 | |
|---|---|---|
| | If RR < 240 | If RR > 240 |
| 0 | 250 | 118 |
| 1 | 250 | 113 |
| 2 | 250 | 108 |
| 3 | 250 | 103 |
| 4 | 250 | 98 |
| 5 | 250 | 94 |
| 6 | 250 | 89 |
| 7 | 250 | 84 |
| 8 | 250 | 79 |

| NT | K<br>Upper Limit for Σ P(k)<br>k=1 | |
|---|---|---|
| | If RR < 240 | If RR > 240 |
| 9 | 250 | 74 |
| 10 | 245 | 70 |
| 11 | 228 | 65 |
| 12 | 210 | 60 |
| 13 | 193 | 55 |
| 14 | 175 | 50 |
| 15 | 158 | 45 |
| 16 | 144 | 41 |
| 17 | 126 | 36 |
| 18 | 109 | 31 |
| 19 | 91 | 26 |
| 20 | 74 | 21 |
| 21 | 60 | 17 |
| >22 | 42 | 12 |

P(k) = power (watts) of the kth interrogation each second. This is the total radiated power (after all losses in cabling and antenna). If the set of powers is not the same in each 1 second period, then Σ P(k) represents the average value.
K = total number of interrogations in a 1 second period.
***Note 1: RR = the Mode A/C interrogation reception rate of own transponder may be used instead of RR = the Mode A/C reply rate of own transponder.***
***Note 2: As an alternative to the above, an active TAS may choose to operate as a low power system at a fixed rate power product limit of 42W/sec, in which case the requirement to further interference limit based on RR or IR is eliminated.***
In lieu of paragraph 2.4.2.5 of RTCA/DO-197A, substitute the following:
This test verifies that Active TAS is able to monitor its own transponder reply rate and to derive a count of TCAS aircraft by listening to TCAS broadcast interrogations and, based on these values, adjust its transmit power-rate product to conform to the Active TAS interference limits.
Inputs:
Active TAS
Aircraft Altitude = 8000 ft.
Altitude Rate = 0 FPM
Intruder Aircraft 1-22
Equipage = Active TCAS II
Range = Not Applicable
Relative Speed = Not Applicable
Altitude = Not Applicable
Altitude Rate = Not Applicable TCAS Broadcast Interrogation
Power = -50 dBm

ATCRBS Interrogation
Frequency = 1030 MHz
Type = ATCRBS Mode C
Power = -50 dBm
Rate
Scenario A = 230 per second

Scenario B = 250 per second

Conditions:
Active TAS initialized and operating at T = 0 seconds. Each of the 22 intruders is assigned a discrete address and transmits only TCAS broadcast interrogations and only at the following times and rates: Intruders 1-10 every 10 sec starting at T = 30 sec. Intruders 11-15 every 20 sec starting at T = 70 sec. Intruders 16-22 every 20 sec starting at T = 130 sec.
The timing of the TCAS broadcast interrogations and the ATCRBS interrogations are controlled to prevent overlap of each other.
Scenario Description
The test involves use of an ATCRBS transponder which supplies reply rate information to Active TAS. The transponder is interrogated in Mode C at a 230 per second rate in Scenario A and at a 250 per second rate in Scenario B. During each scenario, the value of Total Radiated Power per second from Active TAS is measured by summing the transmitter output powers of each Active TAS interrogation over a scan period, determining the average per second value and accounting for cable and antenna losses.
Success: The Total Radiated Power per second shall not exceed the following values:
Scenario A
250 watts/sec measured at T = 20 sec
245 watts/sec measured at T = 60 sec
158 watts/sec measured at T = 120 sec
42 watts/sec measured at T = 180 sec

Scenario B
118 watts/sec measured at T = 20 sec
70 watts/sec measured at T = 60 sec
45 watts/sec measured at T = 120 sec
12 watts/sec measured at T = 180 sec
***Note: For fixed rate power systems, total radiated power is constant and shall not exceed 42 watts/sec.***

1.7 **Active TAS Antenna System**. In lieu of paragraph 2.2.10 of RTCA/DO-197A, substitute the following requirement:
The equipment shall transmit interrogations and receive replies from at least one directional antenna mounted on the top or bottom of the aircraft.

1.8 **Pilot Advisory Functions.** In lieu of paragraph 2.1.5 of RTCA/DO-197A, substitute the following requirement:
TAS is an airborne traffic alert system that interrogates ATC transponders in nearby aircraft and uses computer processing to identify potential and predicted collision threats. The system is designed to protect a volume of airspace around the TAS equipped aircraft. The system will provide appropriate aural and visual advisories to assist the flightcrew in visually acquiring the threat aircraft when TAS predicts a penetration of the protected airspace. Traffic advisories indicate the relative positions of intruding aircraft that meet certain range and altitude criteria and are approximately 30 seconds from closest point of approach. They assist the flightcrew in visually acquiring the intruding aircraft. The system provides a traffic display (Class A systems only) and aural and visual alerts. These indicate the relative position and altitude of ATC transponder-equipped aircraft. Traffic advisories can be generated for aircraft with operative Mode S, Mode C or Mode A (non-altitude reporting) transponders. The TAS equipment is viewed as a supplement to the pilot who, with the aid of the ATC system, has the primary responsibility for avoiding collisions. The TAS system provides no indication of

aircraft without operative transponders. For Class A systems, it shall be acceptable for the TAS system to use shape as the only discriminate for traffic threat levels.
This will allow the use of a monochrome display representation of the TCAS symbology. For Class A systems, it shall also be acceptable to provide a blinking TA symbol to allow further discrimination of the traffic alert symbol.

2.0 **Changes Applicable Only to Class A Equipment**.

2.1 **Pilot Advisory Functions, Active TCAS I Pilot Interface and Aural Alert**.
In lieu of paragraphs 2.1.5, 2.2.12 and 2.2.15 of RTCA/DO-197A, substitute the following requirements:

**1**. A traffic display shall be provided to indicate the presence and location of intruder aircraft. The traffic display may be combined with other aircraft displays. The traffic display shall provide the crew with the intruder's range, bearing, and, for altitude reporting intruders, relative altitude and vertical trend.

**2**. Two levels of intruder aircraft shall be displayed; those causing a TA, and other traffic. Other traffic is defined as any traffic within the selected display range and not a TA.
***Note: The use of TCAS threat levels as defined in DO-197A is an acceptable alternative to the requirements defined in this section.***

**3**. As a minimum, the traffic display shall depict the following information to aid in the visual acquisition of traffic and assist in determining the relative importance of each aircraft shown:
***Note: TCAS I symbology as defined in the FAA Memorandum titled 'Interim Guidance for Airworthiness Approval and Operational Use of Traffic Alert and Collision Avoidance System (TCAS I)' dated June 16, 1995 is an acceptable alternative to the symbology requirements defined in this section.***
***In addition, the use of TCAS symbology with a monochrome display is also an acceptable means of depicting traffic information.***

a. Symbolic differentiation among traffic of different relative importance. TA, other traffic (see i, j, k, l, & m below).

b. Bearing

c. Relative altitude (for altitude reporting aircraft only)
(1) Above or below own aircraft (+ and - signs)
(2) Numerical value

d. Vertical trend of intruder aircraft (for altitude reporting aircraft only).

e. Range. The selected range shall be depicted.

f. The display must be easily readable under all normal cockpit conditions and all expected ambient light conditions from total darkness to bright reflected sunlight.

g. The display shall contain a symbol to represent own aircraft. The symbol shall be different from those used to indicate TA and other traffic. The display shall be oriented such that own aircraft heading is always up (12 o'clock).

h. A ring shall be placed at a range of 2 NM from own aircraft symbol when a display range of 10 NM or less is selected. The ring shall have discrete markings at each of the twelve clock positions. The markings shall be of a size and shape that does not clutter the display.

i. Symbol fill shall be used to discriminate traffic by threat levels

j. The symbol for a TA is a filled rectangle, and, when appropriate, a data field and vertical trend arrow as described in m. & n. below.

k. The symbol for other traffic shall be an open rectangle, and, when appropriate, a data field and vertical trend arrow as described in m. below.

l. Overlapping traffic symbols should be displayed with the appropriate information overlapped. The highest priority traffic symbol should appear on top of other traffic symbols. Priority order is;

1) TA traffic in order of increasing tau, i.e., the time to closest approach and the time to coaltitude,
2) other traffic in order of increasing range.

m. A data field shall indicate the relative altitude, if available, of the intruder aircraft and shall consist of two digits indicating the altitude difference in hundreds of feet.
For an intruder above own aircraft, the data field shall be preceded by a "+" character.
For an intruder below own aircraft, the data field shall be preceded by a "-" character.
For coaltitude intruders, the data field shall contain the digits "00", with no preceding "+" or "-" character. The data field shall be wholly contained within the boundaries of the rectangular traffic symbol.
For TA traffic, (filled symbol), the data characters shall be depicted in a color that contrasts with the filled symbol color.
For other traffic, the data field shall be the same color as the symbol.
The height of the relative altitude data characters shall be no less than 0.15 inches.

n. A vertical arrow should be placed to the immediate right of the traffic symbol if the vertical speed of the intruder is equal to or greater than 500 fpm, with the arrow pointing up for climbing traffic and down for descending traffic.
The color of the arrow shall be the same as the symbol.

o. Neither a data field nor a vertical arrow shall be associated with a symbol for traffic which is not reporting altitude.

p. The display shall be capable of depicting a minimum of three intruder aircraft simultaneously. As a minimum, the display shall be capable of displaying aircraft that are within 5 NM of own aircraft.

q. The display may provide for multiple crew-selectable display ranges.

r. When the range of the intruder causing a traffic advisory to be displayed is greater than the maximum range of the display, this shall be indicated by placing no less than one quarter of the traffic advisory symbol at the edge of the display at the proper bearing. The data field and vertical trend arrow shall be shown in their normal positions relative to the traffic symbol.

s. The size of the traffic symbol shall be no less than 0.2" High.

**4.** "No bearing" advisories shall be presented for an intruder generating a TA when the intruder's relative bearing cannot be derived. The "no bearing" advisory shall be an alphanumeric display shown in tabular form. The display shall be in the form of "TA 3.6 -05", which translates to a TA at 3.6 nautical miles, 500 feet below. "No bearing" TA's against non-altitude reporting intruders shall include the range only, e.g. "TA 2.2", which translates to a non-altitude reporting, no bearing TA at 2.2 nautical miles. The advisory shall be centered on the display below the own aircraft symbol. The display shall include provisions to display at least two "no bearing" TA's.

**5**. Aural Alerts. Each TAS aural alert shall be announced in a high-fidelity, distinguishable voice.

a. The aural alert message "Traffic-Traffic", spoken once, shall be used to inform the crew of a TA.

b. All TAS aural alerts should be inhibited using the following order of precedence;

(1) Below 400 ±100 feet AGL when TAS is installed on an aircraft equipped with a radio altimeter.

(2) For aircraft without a radio altimeter, the aural annunciations shall be inhibited when the landing gear is extended.

***Note: When the TAS is installed on a fixed gear aircraft without a radio altimeter, the aural annunciations will never be inhibited.***

2.2 **Traffic Advisory Criteria.** Replace the second section in paragraph 2.2.14 of RTCA/DO-197A, with the following text:

The TAS equipment shall provide two levels of advisories: Other Traffic (OT), and Traffic Advisories (TA). TAs are issued based on either tau, i.e., the time to closest approach and the time to coaltitude, or proximity to an intruder aircraft. The range tau is defined as the range divided by range rate and the vertical tau is defined as the relative altitude divided by the altitude rate.

2.3 **Display Overload**. In lieu of paragraph 2.2.17 of RTCA/DO-197A, substitute the following requirements:

If the number of targets exceeds the display capability, excess targets shall be deleted in the following order:

a. Other traffic beginning with the intruder at the greatest range.

b. TAs beginning with the intruder having the largest tau. Once a TA has been generated against an intruder, it cannot be removed as a TA until the TA criteria are no longer satisfied even though it may be dropped from the display.

***Note: This exception does not apply when TCAS I symbology and threat levels are used.***

3.0 **Changes Applicable Only to Class B Equipment.**

3.1 **Pilot Advisory Functions, Active TCAS I Pilot Interface, and Aural Alert.**

In lieu of paragraph 2.1.5, 2.2.12, and 2.2.15 of RTCA/DO-197A, substitute the following requirements:

1. A visual "Traffic" annunciation, shall be provided for the duration of the TA.

2. Aural Alerts. For aircraft without a radio altimeter, the aural annunciations shall be inhibited when the landing gear is extended.

***Note: When the TAS is installed on a fixed gear aircraft without a radio altimeter, the aural annunciation will never be inhibited.***

a. Aural alert messages shall be annunciated in threat priority sequence, greatest threat first.

(1) Initial aural traffic advisories shall be spontaneous and unsolicited. The unsolicited annunciations shall be as follows: "Traffic-<X>O'Clock", spoken once, (where <X> is the clock position of the intruder, such as 1 o'clock, etc.). If surveillance bearing information is not available on the intruder, "Traffic, No Bearing", shall be annunciated.
(2) The current relative bearing to intruder aircraft shall be annunciated as a traffic advisory update upon crew command. Additional information such as relative altitude, range of intruder, and vertical trend (i.e. climbing, descending) may also be annunciated.
(3) The acceptability of these aural annunciations must be reviewed during flight test. The following factors, at a minimum, must be evaluated for acceptability: quantity of unsolicited annunciations, duration of annunciations, annunciation clarity, and volume. This evaluation shall occur under normal cockpit workload conditions during departure, cruise, and approach and landing phases of flight and should include evaluation of suitability in a normal air traffic control voice communication environment.
(4) Control means shall be provided to request a traffic advisory update, mute a current aural advisory, and cancel/restore aural advisories (turning the equipment off is an acceptable means of providing the cancel aural advisories function). The default condition of the equipment at power on shall be aural advisories active.

b. All TAS aural alerts should be inhibited using the following order of precedence;

(1) Below 400 ±100 feet AGL when TAS is installed on an aircraft equipped with a radio altimeter.
(2) For aircraft without a radio altimeter, the aural annunciations will never be inhibited in flight but may be inhibited on the ground when the aircraft is equipped with a weight-on-wheels system.

3.2 **Traffic Advisory Criteria**. Replace the first and second sections in paragraph 2.2.14 of RTCA/DO-197A, with the following text:
The Active TAS equipment shall provide two levels of advisories: Other Traffic (OT), and Traffic Advisories (TA). Other traffic is defined as any traffic within the selected display range and not a TA. TAs are issued based on either tau, i.e., the time to closest approach and the time to coaltitude, or proximity to an intruder aircraft. The range tau is defined as the range divided by range rate and the vertical tau is defined as the relative altitude divided by the altitude rate.

3.3 **Display of intruders on the ground**. In lieu of paragraph 2.2.16 of RTCA/DO-197A, substitute the following requirements:
The Active TAS equipment shall provide logic to inhibit TAs of altitude reporting intruders which are on the ground. This logic shall be used when the TAS-equipped aircraft is below 1,700 feet AGL. The 1,700 foot threshold shall include hysteresis of + 50 feet.
Note: This represents a requirement for a capability within the Active TAS avionics. When Active TAS is installed on an aircraft which does not have a radio altimeter, there is not a requirement for this logic to function.

3.4 **Display overload**. In lieu of paragraph 2.2.17 of RTCA/DO-197A, substitute the following requirements:
If the number of intruders exceeds aural memory storage capacity, excess intruders shall be deleted in the following order:

a. Other traffic beginning with the intruder at the greatest range.
b. TAs beginning with the intruder having the largest tau. Once a TA has been generated against an intruder, it cannot be removed as a TA until the TA criteria is no longer satisfied even though it has been dropped from the list of aural warnings.