Tel.:   +1 514-954-7130

Ref.:   AN 7/66.2.2-22/27   29 March 2022

Subject: Adoption of Amendment 91 to Annex 10, Volume IV

Action required: a) Notify any disapproval before 18 July 2022; b) Notify any differences and compliance before 3 October 2022; c) Consider the use of the Electronic Filing of Differences (EFOD) System for notification of differences and compliance

Sir/Madam,

1.   I have the honour to inform you that Amendment 91 to the *International Standards and Recommended Practices, Aeronautical Telecommunications — Surveillance and Collision Avoidance Systems* (Annex 10, Volume IV to the Convention on International Civil Aviation) was adopted by the Council at the eighth meeting of its 225th Session on 7 March 2022. Copies of the Amendment and the Resolution of Adoption are available as attachments to the electronic version of this State letter on the ICAO-NET (http://portal.icao.int) where you can access all other relevant documentation.

2.   When adopting the amendment, the Council prescribed 18 July 2022 as the date on which it will become effective, except for any part concerning which a majority of Contracting States have registered their disapproval before that date. In addition, the Council resolved that Amendment 91, to the extent it becomes effective, will become applicable on 3 November 2022.

3.   Amendment 91 arises from the recommendations developed by the third meeting of the Surveillance Panel (SP/3).

4.   The amendment concerning the introduction of newly developed provisions for airborne collision avoidance system X (ACAS X) is to include the provisions for ACAS Xa (active surveillance) and Xo (operation specific). ACAS Xa is developed for large commercial aircraft. ACAS Xo adds modes that prevent unwanted alerts during parallel runway operations or when maintaining visual separation. The ACAS X provisions in this amendment are based on the outcome of extensive evaluations. Using the safety simulation employed in ACAS II (specifically TCAS Version 7.1) studies, the evaluation outcome indicated that deployment of ACAS Xa would reduce the probability of a Near Mid-Air Collision (NMAC)

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by about 20 per cent, while also reducing the number of unnecessary alerts and resolution advisory (RA) reversals. As these technical provisions fulfil the ACAS II requirements, ACAS X will be an alternative to, while maintaining full interoperability with, existing ACAS II systems, i.e. TCAS Version 7.1.

5.   The amendment concerning a provision to reduce false ACAS alerts addresses the false resolution advisories (RAs) that are sometimes generated when ACAS switches from operating in its passive mode (not interrogating other aircraft) to operating in active mode in the hybrid surveillance capability of current ACAS (TCAS Version 7.1). A fix has been identified and implemented through Service Bulletin and Airworthiness Directive action. This amendment would ensure that Annex 10 is aligned with this fix.

6.   The subjects are given in the amendment to the Foreword of Annex 10, Volume IV, a copy of which is in Attachment A.

7.   In conformity with the Resolution of Adoption, may I request:

a)   that before 18 July 2022 you inform me if there is any part of the adopted Standards and Recommended Practices (SARPs) amendments in Amendment 91 concerning which your Government wishes to register disapproval, using the form in Attachment B for this purpose. Please note that only statements of disapproval need be registered and if you do not reply it will be assumed that you do not disapprove of the amendment;

b)   that before 3 October 2022 you inform me of the following, using the Electronic Filing of Differences (EFOD) System or the form in Attachment C for this purpose:

1)   any differences that will exist on 3 November 2022 between the national regulations or practices of your Government and the provisions of the whole of Annex 10, Volume IV, as amended by all amendments up to and including Amendment 91, and thereafter of any further differences that may arise; and

2)   the date or dates by which your Government will have complied with the provisions of the whole of Annex 10, Volume IV, as amended by all amendments up to and including Amendment 91.

8.   With reference to the request in paragraph 7 a) above, it should be noted that a registration of disapproval of Amendment 91 or any part of it in accordance with Article 90 of the Convention does not constitute a notification of differences under Article 38 of the Convention. To comply with the latter provision, a separate statement is necessary if any differences do exist, as requested in paragraph 7 b) 1). It is recalled in this respect that international Standards in Annexes have a conditional binding force, to the extent that the State or States concerned have not notified any difference thereto under Article 38 of the Convention.

9.   With reference to the request in paragraph 7 b) above, it also should be noted that the ICAO Assembly, at its 39th Session (27 September to 6 October 2016), resolved that Member States should be encouraged to use the EFOD System when notifying differences (Resolution A39-22 refers). The EFOD System is currently available on the Universal Safety Oversight Audit Programme (USOAP) restricted website (http://www.icao.int/usoap) which is accessible by all Member States. You are invited to consider using this for notification of compliance and differences.

10.		Guidance on the determination and reporting of differences is given in the Note on the Notification of Differences in Attachment D. Please note that a detailed repetition of previously notified differences, if they continue to apply, may be avoided by stating the current validity of such differences.

11.		I would appreciate it if you would also send a copy of your notifications, referred to in paragraph 5 b) above, to the ICAO Regional Office accredited to your Government.

12.		At the fifth meeting of its 204th Session, the Council requested that States, when being advised of the adoption of an Annex amendment, be provided with information on implementation and available guidance material, as well as an impact assessment. This is presented for your information in Attachments E and F, respectively.

13.		As soon as practicable after the amendment becomes effective, on 18 July 2022, replacement pages incorporating Amendment 91 will be forwarded to you.

		Accept, Sir/Madam, the assurances of my highest consideration.

		Juan Carlos Salazar
		Secretary General

Enclosures:
	A — Amendment to the Foreword of Annex 10, Volume IV
	B — Form on notification of disapproval of all or part of
		Amendment 91 to Annex 10, Volume IV
	C — Form on notification of compliance with or differences
		from Annex 10, Volume IV
	D — Note on the Notification of Differences
	E — Implementation task list and outline of guidance material
		in relation to Amendment 91 to Annex 10, Volume IV
	F — Impact assessment in relation to Amendment 91 to
		Annex 10, Volume IV

ATTACHMENT A to State letter AN 7/66.2.2-22/27

AMENDMENT TO THE FOREWORD OF ANNEX 10, VOLUME IV

Add the following at the end of Table A:

Amendment	Source(s)	Subject	Adopted/Approved Effective Applicable
91	Third meeting of the Surveillance Panel (SP/3)	Newly developed airborne collision avoidance system X (ACAS X) and a provision to reduce false ACAS alerts.	7 March 2022 18 July 2022 3 November 2022

— — — — — — — —

NOTIFICATION OF DISAPPROVAL OF ALL OR PART OF
AMENDMENT 91 TO ANNEX 10, VOLUME IV

To: The Secretary General
     International Civil Aviation Organization
     999 Robert-Bourassa Boulevard
     Montréal, Quebec
     Canada H3C 5H7

(State) _____ hereby wishes to disapprove the following parts of Amendment 91 to Annex 10, Volume IV:

Signature _____   Date _____

NOTES

1)   If you wish to disapprove all or part of Amendment 91 to Annex 10, Volume IV, please dispatch this notification of disapproval to reach ICAO Headquarters by 18 July 2022. If it has not been received by that date it will be assumed that you do not disapprove of the amendment. **If you approve of all parts of Amendment** 91**, it is not necessary to return this notification of disapproval.**

2)   This notification should not be considered a notification of compliance with or differences from Annex 10, Volume IV. Separate notifications on this are necessary. (See Attachment C.)

3)   Please use extra sheets as required.

— — — — — — — —

NOTIFICATION OF COMPLIANCE WITH OR DIFFERENCES FROM
ANNEX 10, VOLUME IV
(Including all amendments up to and including Amendment 91)

To: The Secretary General
International Civil Aviation Organization
999 Robert-Bourassa Boulevard
Montréal, Quebec
Canada H3C 5H7

1.   No differences will exist on _____ between the national regulations
and/or practices of **(State)** _____ and the provisions of Annex 10,
Volume IV, including all amendments up to and including Amendment 91.

2.   The following differences will exist on _____between the
regulations and/or practices of **(State)** _____ and the provisions
of Annex 10, Volume IV, including Amendment 91 (Please see Note 2) below.)

a) **Annex Provision**	b) **Details of Difference**	c) **Remarks**
(Please give exact paragraph reference)	(Please describe the difference clearly and concisely)	(Please indicate reasons for the difference)

(Please use extra sheets as required)

3.   By the dates indicated below, **(State)** _____ will have complied with the provisions of Annex 10, Volume IV, including all amendments up to and including Amendment 91 for which differences have been notified in 2 above.

   a)   **Annex Provision**   **b)**   **Date**   **c)**   **Comments**
        (Please give exact
        paragraph reference)

(Please use extra sheets as required.)

Signature _____   Date _____

NOTES

1) If paragraph 1 above is applicable to your State, please complete paragraph 1 and return this form to ICAO Headquarters. If paragraph 2 is applicable to you, please complete paragraphs 2 and 3 and return the form to ICAO Headquarters.

2) A detailed repetition of previously notified differences, if they continue to apply, may be avoided by stating the current validity of such differences.

3) Guidance on the notification of differences is provided in the Note on the Notification of Differences and in the *Manual on Notification and Publication of Differences* (Doc 10055).

4) Please send a copy of this notification to the ICAO Regional Office accredited to your Government.

— — — — — — — —

NOTE ON THE NOTIFICATION OF DIFFERENCES
(*Prepared and issued in accordance with instructions of the Council*)

1.   *Introduction*

1.1   Article 38 of the *Convention on International Civil Aviation* ("Convention") requires that a Contracting State notify ICAO any time it does not comply with a Standard in all respects, it does not bring its regulations or practices into full accord with any Standard, or it adopts regulations or practices differing in any particular respect from the Standard.

1.2   The Assembly and the Council, when reviewing the notification of differences by Contracting States in compliance with Article 38 of the Convention, have repeatedly noted that the timeliness and currency of such notifications is not entirely satisfactory. Therefore, this note is issued to reiterate the primary purpose of Article 38 of the Convention and to facilitate the determination and notification of differences.

1.3   The primary purpose of the notification of differences is to promote safety, regularity and efficiency in air navigation by ensuring that governmental and other agencies, including operators and service providers, concerned with international civil aviation are made aware of all national regulations and practices in so far as they differ from those prescribed in the Standards contained in Annexes to the Convention.

1.4   Contracting States are, therefore, requested to give particular attention to the notification of differences with respect to Standards in all Annexes, as described in paragraph 4 b) 1) of the Resolution of Adoption.

1.5   Although differences from Recommended Practices are not notifiable under Article 38 of the Convention, the Assembly has urged Contracting States to extend the above considerations to Recommended Practices contained in Annexes to the Convention, as well.

2.   *Notification of differences from Standards and Recommended Practices (SARPs)*

2.1   Guidance to Contracting States in the notification of differences to Standards and Recommended Practices (SARPs) can only be given in very general terms. Contracting States are further reminded that compliance with SARPs generally extends beyond the issuance of national regulations and requires establishment of practical arrangements for implementation, such as the provision of facilities, personnel and equipment and effective enforcement mechanisms. Contracting States should take those elements into account when determining their compliance and differences. The following categories of differences are provided as a guide in determining whether a notifiable difference exists:

           a) ***A Contracting State's requirement is more exacting or exceeds a SARP (Category A).*** This category applies when the national regulation and practices are more demanding than the corresponding SARP, or impose an obligation within the scope of the Annex which is not covered by the SARP. This is of particular importance where a Contracting State requires a higher standard which affects the operation of aircraft of other Contracting States in and above its territory;

b) ***A Contracting State's requirement is different in character or the Contracting State has established other means of compliance (Category B)**[*]*. This category applies, in particular, when the national regulation and practices are different in character from the corresponding SARP, or when the national regulation and practices differ in principle, type or system from the corresponding SARP, without necessarily imposing an additional obligation; and

c) ***A Contracting State's requirement is less protective, partially implemented or not implemented (Category C)***. This category applies when the national regulation and practices are less protective than the corresponding SARP; when no national regulation has been promulgated to address the corresponding SARP, in whole or in part; or when the Contracting State has not brought its practices into full accord with the corresponding SARP.

These categories do not apply to Not Applicable SARP. Please see the paragraph below.

2.2   **Not Applicable SARP.** When a Contracting State deems a SARP concerning aircraft, operations, equipment, personnel, or air navigation facilities or services to be not applicable to the existing aviation activities of the State, notification of a difference is not required. For example, a Contracting State that is not a State of Design or Manufacture and that does not have any national regulations on the subject, would not be required to notify differences from Annex 8 provisions related to the design and construction of an aircraft.

2.3   **Differences from appendices, tables and figures.** The material comprising a SARP includes not only the SARP itself, but also the appendices, tables and figures associated with the SARP. Therefore, differences from appendices, tables and figures are notifiable under Article 38. In order to file a difference against an appendix, table or figure, States should file a difference against the SARP that makes reference to the appendix, table or figure.

2.4   **Differences from definitions.** Contracting States should notify differences from definitions. The definition of a term used in a SARP does not have independent status but is an essential part of each SARP in which the term is used. Therefore, a difference from the definition of the term may result in there being a difference from any SARP in which the term is used. To this end, Contracting States should take into consideration differences from definitions when determining compliance or differences to SARPs in which the terms are used.

2.5   The notification of differences should be not only to the latest amendment but to the whole Annex, including the amendment. In other words, Contracting States that have already notified differences are requested to provide regular updates of the differences previously notified until the difference no longer exists.

2.6   Further guidance on the identification and notification of differences, examples of well-defined differences and examples of model processes and procedures for management of the notification of differences can be found in the *Manual on Notification and Publication of Differences* (Doc 10055).

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[*] The expression "different in character or other means of compliance" in b) would be applied to a national regulation and practice which achieve, by other means, the same objective as that of the corresponding SARPs or for other substantive reasons so cannot be classified under a) or c).

3. *Form of notification of differences*

3.1   Differences can be notified:

     a) by sending to ICAO Headquarters a form on notification of compliance or differences; or

     b) through the Electronic Filing of Differences (EFOD) System at www.icao.int/usoap.

3.2   When notifying differences, the following information should be provided:

     a) the number of the paragraph or subparagraph which contains the SARP to which the difference relates[*];

     b) the reasons why the State does not comply with the SARP, or considers it necessary to adopt different regulations or practices;

     c) a clear and concise description of the difference; and

     d) intentions for future compliance and any date by which your Government plans to confirm compliance with and remove its difference from the SARP for which the difference has been notified.

3.3   The differences notified will be made available to other Contracting States, normally in the terms used by the Contracting State when making the notification. In the interest of making the information as useful as possible, Contracting States are requested to ensure that:

     a) statements be as clear and concise as possible and be confined to essential points;

     b) the provision of extracts from national regulations not be considered as sufficient to satisfy the obligation to notify differences; and

     c) general comments, unclear acronyms and references be avoided.

— — — — — — — —

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[*] This applies only when the notification is made under 3.1 a).

ATTACHMENT E to State letter AN 7/66.2.2-22/27

**IMPLEMENTATION TASK LIST AND OUTLINE OF GUIDANCE MATERIAL
IN RELATION TO AMENDMENT 91 TO ANNEX 10, VOLUME IV**

1.   **IMPLEMENTATION TASK LIST**

1.1   Essential steps to be followed by a State to implement Amendment 91 to Annex 10, Volume IV will include:

> a)   identification of the rule-making process necessary to transpose the modified ICAO provisions into the national regulations;
>
> b)   establishment of a national implementation plan that takes into account the modified ICAO provisions;
>
> c)   drafting of the modification(s) to the national regulations and means of compliance;
>
> d)   official adoption of the national regulations and means of compliance;
>
> e)   filing of State differences with ICAO, if necessary;
>
> f)   publication of significant differences in the Aeronautical Information Publication (AIP);
>
> g)   update of software for interpretation of ACAS Xa/Xo messages and train their incident investigators on ACAS Xa/Xo functionality if States run an ACAS monitoring programme.

2.   **STANDARDIZATION PROCESS**

2.1   Effective date: 18 July 2022

2.2   Applicability date: 3 November 2022

2.3   Embedded applicability date(s): N/A

3.   **SUPPORTING DOCUMENTATION**

3.1   **ICAO documentation**

Title	Type (PANS/TI/Manual/Circ)	publication date
Airborne Collision Avoidance System (ACAS) Manual (Doc 9863).	Manual	Third edition (2021)

3.2   **External documentation**

Title	External Organization	Publication date
RTCA/DO-385 / EUROCAE/ED-256 (ACAS Xa/Xo MOPS)	RTCA and EUROCAE	2018 and 2019

4.   **IMPLEMENTATION ASSISTANCE TASKS**

Type	Global	Regional
Manufacturer/operator-specific training	An operator that implements a new ACAS system would need to update their training material.	None

5.   **UNIVERSAL SAFETY OVERSIGHT AUDIT PROGRAMME (USOAP)**

5.1   No changes are envisaged in the Protocol Questions (PQs).

— — — — — — — —

**IMPACT ASSESSMENT IN RELATION TO
AMENDMENT 91 TO ANNEX 10, VOLUME IV**

1.   **INTRODUCTION**

1.1   Amendment 91 to Annex 10, Volume IV addresses the introduction of newly developed provisions for airborne collision avoidance system X (ACAS X) and a provision to reduce false ACAS alerts.

2.   **IMPACT ASSESSMENT**

2.1   **Newly developed provisions for airborne collision avoidance system X
        (ACAS X) and a provision to reduce false ACAS alerts**

2.1.1   *Safety impact*: A positive impact is expected due to improved capabilities offered by ACAS Xa/Xo, which are expected to reduce the probability of near mid-air collision and reduce the rate of unnecessary alerts of ACAS Xa/Xo compared to existing ACAS II.

2.1.2   *Financial impact*: The cost impact for States will be minimal as this simply gives an additional option to implement ACAS II. However, States that will accept ACAS Xa/Xo-compliant equipment in their airspace and that run an ACAS monitoring program need to update their message interpretation software.

2.1.3   *Security impact*: None.

2.1.4   *Environmental impact*: A positive impact is expected due to a significant reduction of nuisance alerts and resolution advisory. This will reduce occurrences of go-around and disruptive manoeuvring, thereby consequently reducing fuel consumption and noise impact.

2.1.5   *Efficiency impact*: A positive impact is expected due to a significant reduction of nuisance alerts and resolution advisory. This will result in the reduction of disruptive manoeuvrings and will promote efficient aircraft operations.

2.1.6   *Expected implementation time*: This could be implemented in a relatively short time frame (one to two years) for many States. However, States accepting ACAS Xa/Xo -compliant equipment in their airspace that also run an ACAS monitoring program may take longer to implement since both ACAS message interpretation software and State regulations should be updated.

— END —

AMENDMENT 91

TO THE

**INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES**

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

**VOLUME IV
SURVEILLANCE AND COLLISION AVOIDANCE SYSTEMS**

The amendment to Annex 10, Volume IV contained in this document was adopted by the Council of ICAO on **7 March 2022**. Such parts of this amendment as have not been disapproved by more than half of the total number of Contracting States on or before **18 July 2022** will become effective on that date and will become applicable on **3 November 2022** as specified in the Resolution of Adoption. (State letter AN 7/66.2.2-22/27 refers.)

MARCH 2022

INTERNATIONAL CIVIL AVIATION ORGANIZATION

**AMENDMENT 91 TO THE INTERNATIONAL STANDARDS AND
RECOMMENDED PRACTICES**

**ANNEX 10 — *AERONAUTICAL TELECOMMUNICATIONS*
VOLUME IV — *SURVEILLANCE AND COLLISION AVOIDANCE SYSTEMS***

RESOLUTION OF ADOPTION

The Council

Acting in accordance with the Convention on International Civil Aviation, and particularly with the provisions of Articles 37, 54 and 90 thereof,

1.   *Hereby adopts* on 7 March 2022 Amendment 91 to the International Standards and Recommended Practices contained in the document entitled *International Standards and Recommended Practices, Aeronautical Telecommunications — Surveillance and Collision Avoidance Systems* which for convenience is designated Annex 10, Volume IV to the Convention;

2.   *Prescribes* 18 July 2022 as the date upon which the said amendment shall become effective, except for any part thereof in respect of which a majority of the Contracting States have registered their disapproval with the Council before that date;

3.   *Resolves* that the said amendment or such parts thereof as have become effective shall become applicable on 3 November 2022;

4.   *Requests the Secretary General*:

   a) to notify each Contracting State immediately of the above action and immediately after 18 July 2022 of those parts of the amendment which have become effective;

   b) to request each Contracting State:

      1) to notify the Organization (in accordance with the obligation imposed by Article 38 of the Convention) of the differences that will exist on 3 November 2022 between its national regulations or practices and the provisions of the Standards in the Annex as hereby amended, such notification to be made before 3 October 2022, and thereafter to notify the Organization of any further differences that arise;

      2) to notify the Organization before 3 October 2022 of the date or dates by which it will have complied with the provisions of the Standards in the Annex as hereby amended;

   c) to invite each Contracting State to notify additionally any differences between its own practices and those established by the Recommended Practices, following the procedure specified in subparagraph b) above with respect to differences from Standards.

— — — — — — — —

NOTES ON THE PRESENTATION OF THE
AMENDMENT TO ANNEX 10, VOLUME IV

1.   The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

~~Text to be deleted is shown with a line through it.~~	text to be deleted
New text to be inserted is highlighted with grey shading.	new text to be inserted
~~Text to be deleted is shown with a line through it~~ followed by the replacement text which is highlighted with grey shading.	new text to replace existing text

2.   The source of the amendments arises from the third meeting of Surveillance Panel (SP/3).

TEXT OF AMENDMENT 91

TO THE

**INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES**

AERONAUTICAL TELECOMMUNICATIONS

**ANNEX 10
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION**

**VOLUME IV
SURVEILLANCE AND COLLISION AVOIDANCE SYSTEMS**

. . .

CHAPTER 1.   DEFINITIONS

. . .

Airborne collision avoidance system (ACAS). An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

   Note.— SSR transponders referred to above are those operating in Mode C or Mode S. ACAS may also use automatic dependent surveillance — broadcast (ADS-B) signals received from other aircraft to improve its performance.

. . .

CHAPTER 4.   AIRBORNE COLLISION AVOIDANCE SYSTEM

. . .

   ~~*Note 1.—   Guidance material relating to the airborne collision avoidance system is contained in the* Airborne Collision Avoidance System (ACAS) Manual *(Doc 9863).*~~

   ~~*Note 2.—   Non-SI alternative units are used as permitted by Annex 5, Chapter 3, 3.2.2. In limited cases, to ensure consistency at the level of the logic calculations, units such as ft/s, NM/s and kt/s are used.*~~

   ~~*Note 3.—   The system that is compliant with Chapter 4 in its entirety is the one that incorporates the traffic alert and collision avoidance systems (TCAS) Version 7.1 and therefore meets the RTCA/DO-185B or EUROCAE/ED-143 specification.*~~

   ~~*Note 4.—   Equipment complying with RTCA/DO-185A standards (also known as TCAS Version 7.0) is*~~

not compliant with Chapter 4 in its entirety.

Introductory Note.— This chapter contains SARPs on ACAS I, ACAS II and ACAS III. The focus is especially on ACAS II which provides vertical resolution advisories (RAs) in addition to traffic advisories (TAs), and the related provisions are detailed in the following sections:

- *4.3 GENERAL PROVISIONS RELATING TO ACAS II AND ACAS III*
- *4.4 PERFORMANCE OF THE ACAS II COLLISION AVOIDANCE LOGIC and*
- *4.5 ACAS USE OF EXTENDED SQUITTER*

ACAS X and TCAS Version 7.1 are considered as ACAS II systems. The provisions for ACAS X compliant systems in this chapter cover ACAS Xa (a stands for active surveillance, which is its main surveillance source) and ACAS Xo (o stands for operation specific). ACAS Xa is developed for large commercial aircraft. ACAS Xo is a specific variation of ACAS X that adds special modes to ACAS Xa.

ACAS X is an alternative to, and interoperable with, TCAS Version 7.1 compliant systems. However, there are differences between ACAS X and TCAS Version 7.1, mainly in two areas: the collision avoidance logic and the sources of surveillance data. With these differences, technical requirements which are specific to either ACAS X or TCAS version 7.1 are identified within this Annex as "For ACAS X compliant systems" or "For TCAS 7.1 compliant systems".

Guidance material related to both ACAS X compliant systems and TCAS 7.1 compliant systems including similarities and differences (e.g. monitoring and training) are contained in the Airborne Collision Avoidance System (ACAS) Manual (Doc 9863).

It is to be noted that hybrid and extended hybrid surveillance provisions contained in section 4.5 describe functionalities which are optional for TCAS version 7.1 compliant systems. However, their use is encouraged in order to minimize the risk of ACAS RF spectrum congestion, as proper and efficient utilization of available bandwidth and capacity at 1 030 MHz and 1 090 MHz is a key element to ensure the safe operation of not only ACAS but also several surveillance systems such as secondary surveillance radar (SSR) and automatic dependent surveillance broadcast (ADS-B). These functionalities are included in ACAS X compliant systems.

Non-SI alternative units are used as permitted by Annex 5, Chapter 3, 3.2.2. In limited cases, to ensure consistency at the level of the logic calculations, units such as ft/s, NM/s and kt/s are used.

For more details of TCAS Version 7.1 compliant systems, refer to the RTCA/DO-185B or EUROCAE/ED-143 specifications, i.e. equipment that incorporates the traffic alert and collision avoidance systems (TCAS) Version 7.1. For ACAS X compliant systems, refer to the RTCA/DO-385 or EUROCAE/ED-256 specifications, i.e. equipment that incorporates the airborne collision avoidance system X (ACAS X). Equipment meeting the ACAS X or TCAS Version 7.1 specifications listed above are compliant with the ACAS II requirements listed in Chapter 4. Equipment meeting the RTCA/DO-185A specifications (also known as TCAS Version 7.0) are not compliant with the ACAS II requirements listed in Chapter 4.

. . .

6

4.1   DEFINITIONS RELATING TO
AIRBORNE COLLISION AVOIDANCE SYSTEM

. . .

Intruder. An ~~SSR transponder-equipped~~ aircraft ~~within the surveillance range of ACAS~~ for which ACAS has an established track.

. . .

Sensitivity level (S). An integer defining a set of parameters used by the traffic advisory (TA) and collision avoidance algorithms to control the warning time provided by the potential threat and threat detection logic, as well as the values of parameters relevant to the RA selection logic.

> *Note.— For TA and RA selection, sensitivity level is not used in ACAS X compliant systems.*

. . .

Track. A sequence of ~~at least three~~ measurements representing positions that could reasonably have been occupied by an aircraft.

. . .

4.3.2   Surveillance performance requirements

4.3.2.1   *General surveillance requirements.* ACAS shall interrogate SSR Mode A/C and Mode S transponders in other aircraft and detect the transponder replies. ACAS shall measure the range and relative bearing of responding aircraft. For ACAS X compliant systems, in addition to information from other sources described above, ACAS shall be able to receive other aircraft's ADS-B position, velocity and status information. Using these measurements and information conveyed by transponder replies and for ACAS X compliant systems also by ADS-B messages, ACAS shall estimate the relative positions of each responding aircraft. ACAS shall include provisions for achieving such position determination in the presence of ground reflections, interference and variations in signal strength.

. . .

4.3.2.1.2   *False track probability.* The probability that an established Mode A/C track does not correspond in range and altitude, if reported, to an actual aircraft shall be less than ~~10^{-2}~~ 1.2 per cent. For an established Mode S track this probability shall be less than ~~10^{-6}~~ 0.1 per cent. These limits shall not be exceeded in any traffic environment.

. . .

4.3.3   Traffic advisories (TAs)

. . .

4.3.3.2   PROXIMATE TRAFFIC DISPLAY

. . .

4.3.3.2.2   **Recommendation.—** *While any RA and/or TA are displayed, visual acquisition of the threats and/or potential threat should not be adversely affected by the display of proximate traffic or other*

data (e.g. contents of received ADS-B messages) unrelated to collision avoidance.

4.3.3.3   *TAs as RA precursors.* The criteria for TAs shall be such that they are satisfied before those for an RA.

Note. — Ideally, RAs would always be preceded by a TA but this is not always possible, e.g. the RA criteria might be already satisfied when a track is first established, or a sudden and sharp manoeuvre by the intruder could cause the TA lead time to be less than a cycle.

4.3.3.3.1   *TA warning time.*

4.3.3.3.1.1   For TCAS Version 7.1 compliant systems ~~intruders reporting altitude~~, the nominal TA warning time for intruders reporting altitude shall not be greater than (T+20 s) where T is the nominal warning time for the generation of the resolution advisory.

~~Note. — Ideally, RAs would always be preceded by a TA but this is not always possible, e.g. the RA criteria might be already satisfied when a track is first established, or a sudden and sharp manoeuvre by the intruder could cause the TA lead time to be less than a cycle.~~

4.3.3.3.1.2   For ACAS X compliant systems, the TA warning time shall be sufficient to allow the flight crew to take actions described in PANS-OPS, Volume III and prepare for a potential resolution advisory.

Note.— The nominal TA warning time is 20 s or less before the generation of the resolution advisory.

4.3.4   Threat detection

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4.3.4.1.1   *Intruder characteristics.* As a minimum, the characteristics of an intruder that are used to identify a threat shall include:

a)   tracked altitude;

b)   tracked rate of change of altitude;

c)   tracked slant range;

d)   tracked rate of change of slant range; and

e)   for TCAS Version 7.1 compliant systems: sensitivity level of intruder's ACAS, S_i.

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4.3.4.2   *Sensitivity levels.* ACAS shall be capable of operating at any of a number of sensitivity levels. These shall include:

a) $S = 1$, a "standby" mode in which the interrogation of other aircraft and all advisories are inhibited;

b) $S = 2$, a "TA only" mode in which RAs are inhibited; ~~and~~

c)   for TCAS Version 7.1 compliant systems: $S = 3$-7, further levels that enable the issue of RAs that provide the warning times indicated in Table 4-2 as well as TAs~~.~~; and

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d) for ACAS X compliant systems: $S = 3$, a "TA/RA" mode in which RAs and TAs can be issued.

4.3.4.3 *Selection of own sensitivity level (S_o).* The selection of own ACAS sensitivity level shall be determined by sensitivity level control (SLC) commands which shall be accepted from a number of sources as follows:

a) SLC command generated automatically by ACAS based on altitude band or other external factors;

b) SLC command from pilot input; and

c) for TCAS Version 7.1 compliant systems: SLC command from Mode S ground stations.

Note. — ACAS X compliant systems acknowledge SLC commands from ground stations so that the ground stations do not need to be modified for these commands. However, the sensitivity level value is not used in ACAS X compliant systems.

Table 4-2

For TCAS Version 7.1 compliant systems:

Sensitivity level	2	3	4	5	6	7
Nominal warning time	no RAs	15s	20s	25s	30s	35s

4.3.4.3.1 *Permitted SLC command codes.* As a minimum, the acceptable SLC command codes shall include:

		Coding
for SLC based on altitude band	2-7	(for TCAS Version 7.1 compliant systems)
	2-3	(for ACAS X compliant systems)
for SLC from pilot input	0,1,2	
for SLC from Mode S ground stations	0,2-6	(for TCAS Version 7.1 compliant systems)

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4.3.4.3.4 *Mode S ground station SLC command.*

4.3.4.3.4.1 For TCAS Version 7.1 compliant systems: For SLC commands transmitted via Mode S ground stations (4.3.8.4.2.1.1), the value 0 shall indicate that the station concerned is not issuing an SLC command and that sensitivity level selection shall be based on the other commands, including non-0 commands from other Mode S ground stations. ACAS shall not process an uplinked SLC value of 1.

4.3.4.3.4.2 For ACAS X compliant systems: ACAS shall receive any SLC commands from Mode S ground stations but shall not use their sensitivity level values.

4.3.4.3.4.~~13~~   *ATS selection of SLC command code.* ATS authorities shall ensure that procedures are in place to inform pilots of any ATS selected SLC command code other than 0 (4.3.4.3.1).

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4.3.4.4   *Selection of parameter values for RA generation.* For TCAS Version 7.1 compliant systems: When the sensitivity level of own ACAS is 3 or greater, the parameter values used for RA generation that depend on sensitivity level shall be based on the greater of the sensitivity level of own ACAS, S_o, and the sensitivity level of the intruder's ACAS, S_i.

4.3.4.5   *Selection of parameter values for TA generation.* For TCAS Version 7.1 compliant systems: The parameter values used for TA generation that depend on sensitivity level shall be selected on the same basis as those for RAs (4.3.4.4) except when an SLC command with a value of 2 ("TA only" mode) has been received from either the pilot or a Mode S ground station. In this case, the parameter values for TA generation shall retain the values they would have had in the absence of the SLC command from the pilot or Mode S ground station.

4.3.4.6   *Validation of ADS-B tracks for RA generation.* For ACAS X compliant systems: If ADS-B tracks fail validation via active interrogation and reply, ACAS shall revert back to using active surveillance for threat resolution logic.

   Note.— Only validated ADS-B is used in the generation of RAs.

4.3.4.7   *Designation of aircraft for do not alert (DNA).* For ACAS X compliant systems with Xo functionality: If an intruder aircraft is designated as do not alert (DNA), no alerts for the intruder aircraft shall be issued to the flight crew of the own aircraft.

   Note. — ACAS Xo provides additional modes with modified threat detection criteria in respect of designated intruders. For more details on ACAS Xo, refer to RTCA/DO-385 or EUROCAE/ED-256.

4.3.5   Resolution advisories (RAs)

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4.3.5.1.2   *RA cancellation.*

4.3.5.1.2.1   For TCAS 7.1 compliant systems: Once an RA has been generated against a threat or threats it shall be maintained or modified until tests that are less stringent than those for threat detection indicate on two consecutive cycles that the RA may be cancelled, at which time it shall be cancelled.

4.3.5.1.2.2   For ACAS X compliant systems: Once an RA has been generated against a threat or threats it shall be maintained until the intruder or intruders of the RA cease to be a threat.

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4.3.5.3.1   New ACAS installations after 1 January 2014 shall monitor own aircraft's vertical rate to verify compliance with the RA sense. If non-compliance is detected, ACAS shall stop assuming compliance, and instead shall assume the observed vertical rate.

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   Note 3.— Compliance with this requirement can be achieved through the implementation of traffic alert and collision avoidance system (TCAS) Version 7.1 as specified in RTCA/DO-185B, ~~or~~ EUROCAE/ED-

143 or airborne collision avoidance system X (ACAS Xa and Xo) as specified in RTCA/DO-385 or EUROCAE/ED-256.

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    4.3.5.4.2   ACAS shall ~~not~~ operate in TA only mode ~~sensitivity levels 3–7~~ when own aircraft is below 300 m (1 000 ft) AGL nominal value with hysteresis applied.

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    4.3.5.5.2   *Sense reversals due to inadequate predicted separation.* ACAS shall initiate not more than one reversal per threat per encounter due to inadequate predicted separation.

    Note 1.— For TCAS Version 7.1 compliant systems: The aircraft with the lower 24-bit aircraft address can initiate this type of reversal at any time during the encounter; the aircraft with the higher 24-bit aircraft address performs this type of reversal only to comply with an RAC received from the aircraft with a lower 24-bit aircraft address.

    Note 2.— For ACAS X compliant systems: In a coordinated encounter as described in section 4.3.6.1, the aircraft with the lower 24-bit aircraft address can initiate this type of reversal at any time during the encounter; the aircraft with the higher 24-bit aircraft address can initiate this type of reversal only before it has received an RAC from the threat or after receiving cancellation of any remaining RAC from the threat.

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    4.3.5.9   *Encoding of ARA subfield.* On each cycle of an RA, the RA sense, strength and attributes shall be encoded in the active RA (ARA) subfield (4.3.8.4.2.2.1.1). ~~If the ARA subfield has not been refreshed for an interval of 6 s, it shall be set to 0, along with the MTE subfield in the same message (4.3.8.4.2.2.1.3).~~

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4.3.6   Coordination and communication

4.3.6.1   PROVISIONS FOR COORDINATION WITH ACAS-EQUIPPED THREATS

    Note 1.— The provisions in this section apply to aircraft that coordinate with ACAS equipped aircraft via 1 030/1 090 MHz discrete Mode S interrogations/replies.

    Note 2.— ACAS equipment not capable of utilizing 1 030/1 090 MHz discrete Mode S interrogations/replies and that will use ADS-B to convey the applicable coordination scheme is under development. ACAS X-compliant systems incorporate the ability to coordinate with threats using such ACAS equipment. For more details, refer to Section 2.2.3.9.3.1 of RTCA/DO-385 or EUROCAE/ED-256.

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    4.3.6.1.4   *Resolution message processing.* Resolution messages shall be processed in the order in which they are received and with delay limited to that required to prevent possible concurrent access to stored data and delays due to the processing of previously received resolution messages. Resolution messages that are being delayed shall be temporarily queued to prevent possible loss of messages. Processing a resolution message shall include decoding the message and updating the appropriate data structures with the information extracted from the message.

Note 1.— For TCAS Version 7.1 compliant systems: According to 4.3.6.1.2, resolution message processing must not access any data whose usage is not protected by the coordination lock state.

Note 2.— For ACAS X compliant systems: Simultaneous data access may exist because incoming resolution messages are received asynchronously to ACAS X processing, effectively interrupting this processing. Simultaneous reading and writing by concurrent processes are to be prevented.

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4.3.6.2.2   *Sensitivity level control (SLC) command.* For TCAS Version 7.1 compliant systems: ACAS shall store SLC commands from Mode S ground stations. An SLC command received from a Mode S ground station shall remain effective until replaced by an SLC command from the same ground station as indicated by the site number contained in the IIS subfield of the interrogation. If an existing stored command from a Mode S ground station is not refreshed within 4 minutes, or if the SLC command received has the value 15 (4.3.8.4.2.1.1), the stored SLC command for that Mode S ground station shall be set to 0.

Note.— ACAS X compliant systems do not use the sensitivity level value obtained from an SLC command to modify the sensitivity level value of own aircraft.

4.3.6.3   PROVISIONS FOR DATA TRANSFER BETWEEN ACAS AND ITS MODE S TRANSPONDER

4.3.6.3.1   Data transfer from ACAS to its Mode S transponder:

a)   ACAS shall transfer RA information to its Mode S transponder for transmission in an RA report (4.3.8.4.2.2.1) and in a coordination reply (4.3.8.4.2.4.2);

b)   ACAS shall transfer current sensitivity level to its Mode S transponder for transmission in a sensitivity level report (4.3.8.4.2.5); and

c)   ACAS shall transfer capability information to its Mode S transponder for transmission in a data link capability report (4.3.8.4.2.2.2).

Note.— For ACAS X compliant systems: ACAS will not transfer a sensitivity level value greater than 3 as part of the capability information to its Mode S transponder.

4.3.6.3.2   Data transfer from Mode S transponder to its ACAS:

a)   ACAS shall receive from its Mode S transponder sensitivity level control commands (4.3.8.4.2.1.1) transmitted by Mode S ground stations;

Note.— For ACAS X compliant systems: It is necessary to receive SLC commands from the transponder to be compliant with the interface protocols between the Mode S transponder and the ACAS unit; however, the sensitivity level values are not used (refer to 4.3.4.3.4).

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4.3.7   ACAS protocols

4.3.7.1   SURVEILLANCE PROTOCOLS

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4.3.7.1.3   SURVEILLANCE OF ADS-B MESSAGES FROM INTRUDER AIRCRAFT FOR ACAS X COMPLIANT

SYSTEMS:

4.3.7.1.3.1   *Detection.* ACAS shall monitor 1 090 MHz extended squitter.

4.3.7.1.3.2   ACAS shall receive and use 1 090 MHz extended squitter messages which include information on ADS-B airborne and surface position, airborne velocity, target state and status, and aircraft operational status.

4.3.7.2   AIR-AIR COORDINATION PROTOCOLS

Note 1.— The provisions in this section apply to aircraft that coordinate with ACAS equipped aircraft via 1 030/1 090 MHz discrete Mode S interrogations/replies.

Note 2.— ACAS equipment not capable of utilizing 1 030/1 090 MHz discrete Mode S interrogations/replies and that will use ADS-B to convey the applicable coordination scheme is under development. ACAS X compliant systems incorporate the ability to coordinate with threats using such ACAS equipment. For more details, refer to Section 2.2.3.9.3.1 of RTCA/DO-385 or EUROCAE/ED-256.

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4.3.7.3   PROTOCOLS FOR ACAS COMMUNICATION WITH GROUND STATIONS

4.3.7.3.1   *RA reports to Mode S ground stations.* These protocols are described in 4.3.11.4.1.

4.3.7.3.2   *RA broadcasts.* RA broadcasts shall be transmitted at full power from the bottom antenna at jittered ~~nominally 8 s intervals for the period that the RA is indicated~~ intervals. The RA broadcast shall include the MU field as specified in 4.3.8.4.2.3.4. The RA broadcast shall describe the ~~most recent~~ current RA ~~that existed during the preceding 8 s period~~. Installations using directional antennas shall operate such that complete circular coverage is provided ~~nominally every 8 s and the same RA sense and strength is broadcast in each direction~~.

Note. — The nominal jittered interval of RA broadcasts is every 8 s for the majority of ACAS legacy systems and 1 s for ACAS X compliant systems.

4.3.7.3.3   *Data link capability report.* These protocols are described in 4.3.11.4.2.

4.3.7.3.4   *ACAS sensitivity level control.*

4.3.7.3.4.1   For TCAS Version 7.1 compliant systems: ACAS shall act upon an SLC command if and only if TMS (Chapter 3, 3.1.2.6.1.4.1) has the value 0 and DI is either 1 or 7 in the same interrogation.

4.3.7.3.4.2   For ACAS X compliant systems: ACAS shall receive any SLC commands from Mode S ground stations but shall not use their sensitivity level values.

4.3.8   Signal formats

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4.3.8.2   RELATIONSHIP BETWEEN ACAS AND MODE S SIGNAL FORMATS

Note.— ACAS uses Mode S transmissions for surveillance and communications. ACAS air-air communication functions permit RA decisions to be coordinated with ACAS-equipped threats. ACAS air-ground communication functions permit the reporting of RAs to ground stations ~~and the uplinking of~~

commands to ACAS-equipped aircraft to control parameters of the collision avoidance algorithms.

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4.3.8.4   FIELD DESCRIPTION

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4.3.8.4.1   *FIELDS AND SUBFIELDS INTRODUCED IN CHAPTER 3, 3.1.2*

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4.3.8.4.1.2   *RI (air-air reply information).* The significance of the coding in the RI field shall be as follows:

Coding
0	No operating ACAS
1	Not assigned
2	ACAS with resolution capability inhibited
3	ACAS with vertical-only resolution capability and capability to utilize 1 030/1 090 MHz discrete Mode S interrogations/replies for coordination
4	ACAS with vertical and horizontal resolution capability and capability to utilize 1 030/1 090 MHz discrete Mode S interrogations/replies for coordination
5-6	Reserved for passive ACAS
5-7	Not assigned
8-15	See Chapter 3, 3.1.2.8.2.2

. . .

4.3.8.4.2   *ACAS FIELDS AND SUBFIELDS*

Note.— The following paragraphs describe the location and coding of those fields and subfields that are not defined in Chapter 3, 3.1.2 but are used by aircraft equipped with ACAS.

4.3.8.4.2.1   *For TCAS Version 7.1 compliant systems: Subfield in MA*

. . .

4.3.8.4.2.1.3   *SLC (ACAS sensitivity level control (SLC) command).* This 4-bit (41-44) subfield shall denote a sensitivity level command for own ACAS.

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Note 1.— Structure of MA for a sensitivity level control command:

. . .

Note 2.— ACAS X compliant systems receive SLC commands but their sensitivity level values are not used.

4.3.8.4.2.2   *Subfields in MB*

Note.— 4.3.8.4.2.2.1 is applicable to TCAS Version 7.1 compliant systems, while 4.3.8.4.2.2.2 is applicable to ACAS X compliant systems. 4.3.8.4.2.2.3 is applicable to both TCAS Version 7.1 and ACAS X compliant systems.

4.3.8.4.2.2.1   *For TCAS Version 7.1 compliant systems: Subfields in MB for an RA report.* When BDS1=3 and BDS2=0, the subfields indicated below shall be contained in MB.

…

Note 1.— When ARA bit 41 = 0 and MTE = 0, no vertical RA has been generated.

Note 2.— An RA is considered crossing if own aircraft is expected to cross the altitude of the intruder before closest approach, e.g. pass above a threat currently above own aircraft. An RA is considered crossing regardless of whether the word "crossing" is included in the aural annunciation.

…

4.3.8.4.2.2.2   *For ACAS X compliant systems: Subfields in MB for an RA report.* When BDS1=3 and BDS2=0, the subfields indicated below shall be contained in MB.

4.3.8.4.2.2.2.1   *ARA (active RAs).* This 10-bit (41-50) subfield shall indicate the currently active RA if any generated by own ACAS X unit against one or more threat aircraft.

The ARA subfield is further divided into:

a) *AVRA (vertical RA).* This 7-bit (41-47) subfield contains the vertical component of the ARA as defined below; and

b) *AHRA (horizontal RA)* .This 3-bit (48-50) subfield contains the horizontal component of the ARA. For ACAS X compliant systems, AHRA=0.

Bits 41-50 shall have the following meanings:

Bit	Coding	
41	0	Different vertical senses have been generated in a multi-threat encounter (when MTE = 1); or no RA has been generated (when MTE=0)
	1	The same vertical sense has been generated in a single or multi-threat encounter
42	0	RA is not crossing
	1	RA is crossing
43	0	Upward sense RA has been generated (i.e. own aircraft intent is to pass above the threat)
	1	Downward sense RA has been generated (i.e. own aircraft intent is to pass below the threat)
44		Strength bit 1
45		Strength bit 2
46		Strength bit 3
47		Strength bit 4
48-50	0	AHRA

Note. —An RA is considered crossing if own aircraft is expected to cross the altitude of the intruder before closest approach, e.g., pass above a threat currently above own aircraft. An RA is considered crossing regardless of whether the word "crossing" is included in the aural annunciation.

The strength bits indicated in bits 44 - 47 shall have the following meaning:

Strength bits 1 2 3 4		
0 0 0 0	0	Clear of conflict
0 0 0 1	1	Monitor vertical speed
0 0 1 0	2	Level-off; weakening of positive RA
0 0 1 1	3	Level-off; corrective when climbing/descending
0 1 0 0	4	Climb/descend at 1500 ft/min
0 1 0 1	5	Reversal to climb/descend
0 1 1 0	6	Increase climb/descend
0 1 1 1	7	Maintain rate; at current rate > 1500 ft/min
1 0 0 0	8	Reversal to maintain
1 0 0 1	9	Level-off; reversal to corrective negative RA
1 0 1 0	10	Monitor vertical speed; following descend RA, descend inhibited
1 0 1 1	11	Monitor vertical speed; reversal to preventive negative RA
1 1 0 0	12	Unallocated
1 1 0 1	13	Unallocated
1 1 1 0	14	Preventive multi-threat level off (MTLO) while level
1 1 1 1	15	Corrective MTLO while climbing/descending

Note. — For MTLO own aircraft with -500 ft/min to +500 ft/min is "level"; own aircraft with vertical rate > 500 ft/min is "climbing" and own aircraft with vertical rate < -500 ft/min is "descending"

4.3.8.4.2.2.2.2   *LDI (low-level descend inhibit).* This 2-bit (51-52) subfield is derived from the own aircraft radar altimeter value and shall indicate whether own aircraft is in a region where low level descend inhibits may be applied. The coding shall have the following meanings:

Bits 51-52 Coding	
0	No descend inhibit
1	Increase descend RAs inhibited
2	Both increase descend RAs and descend RAs inhibited
3	All RAs are inhibited

4.3.8.4.2.2.2.3   *RMF (RA message format).* This 2-bit (53-54) subfield indicates the collision avoidance (CA) system used to generate bits 41-88 of the RF message. The coding shall have the following meanings:

Bits 53-54 Coding	
0	All TCAS II versions
1	ACAS X compliant system
2	Reserved for ACAS III
3	Unallocated

4.3.8.4.2.2.2.4   *RAC (RACs record).* This 4-bit (55-58) subfield shall indicate all the currently active

RACs, if any, received from other ACAS aircraft. The bits in RAC shall have the following meanings:

Bit   *Resolution advisory complement*
55   Do not pass below
56   Do not pass above
57   Reserved for horizontal coordination
58   Reserved for horizontal coordination

A bit set to 1 shall indicate that the associated RAC is active. A bit set to 0 shall indicate that the associated RAC is inactive.

4.3.8.4.2.2.2.5   *RAT (RA terminated indicator).* This 1-bit (59) subfield shall indicate when an RA previously generated by ACAS has ceased being generated.

Coding
0   ACAS is currently generating the RA indicated in the ARA subfield
1   The RA indicated by the ARA subfield has been terminated
       (4.3.11.4.1)

Note 1. — After an RA has been terminated by ACAS, it is still required to be reported by the Mode S transponder for 18±1 s (4.3.11.4.1). The RA terminated indicator may be used, for example, to permit timely removal of an RA indication from an air traffic controller's display, or for assessments of RA duration within a particular airspace.

Note 2. — RAs may terminate for a number of reasons: normally, when the conflict has been resolved and the threat is diverging in range; or when the threat's Mode S transponder for any reason ceases to report altitude during the conflict. The RA terminated indicator is used to show that the RA has been removed in each of these cases.

4.3.8.4.2.2.2.6   *MTE (multiple threat encounter).* This 1-bit (60) subfield shall indicate whether two or more simultaneous threats are currently being processed by the ACAS threat resolution logic.

Coding
0   One threat is being processed by the resolution logic (when ARA bit 41 = 1); or
       no threat is being processed by the resolution logic (when ARA bit 41 = 0)
1   Two or more simultaneous threats are being processed by the resolution logic

4.3.8.4.2.2.2.7   *CNT (continuation bit).* This 1-bit subfield (61) shall indicate whether a follow-on RF message is being generated to report additional information.

Coding
0   No follow-on RF message exists
1   A follow-on RF message exists

4.3.8.4.2.2.2.8   *TTI (threat type indicator subfield).* This 1-bit subfield (62) shall define the type of identity data contained in the TID subfield.

Coding
0   TID contains altitude, range and bearing data
1   TID contains a 24-bit aircraft address

4.3.8.4.2.2.2.9   *TID (threat identity data subfield).* This 24-bit subfield (63-86) shall contain the 24-bit aircraft address of the threat or the altitude, range, and bearing if the threat is not Mode S equipped. If two or more threats are simultaneously processed by the ACAS resolution logic, TID shall contain the

identity or position data for the most recently declared threat. If TTI = 1, TID shall contain in bits 63-86 the aircraft address of the threat. If TTI = 0, TID shall contain the following three subfields (refer to 4.3.8.4.2.2.2.8).

4.3.8.4.2.2.2.9.1   *TIDA (threat identity data altitude subfield).* This 11-bit subfield (63-73) shall contain the most recent threat altitude estimated by ACAS, expressed in binary to a resolution of 100 ft as follows.

> *Coding*
> 0   No data
> 1   Alt < -950 ft
> 2   -950 ft ≤ Alt < -850 ft
> 3   -850 ft ≤ Alt < -750 ft
> 4….

4.3.8.4.2.2.2.9.2   *TIDR (threat identity data range subfield).* This 7-bit subfield (74-80) shall contain the most recent threat range estimated by ACAS.

> *Coding (n)*
> *n*   *Estimated range (NM)*
> 0   No range estimate available
> 1   Less than 0.05
> 2-126 $(n-1)/10 \pm 0.05$
> 127   Greater than 12.55

4.3.8.4.2.2.2.9.3   *TIDB (threat identity data bearing subfield).* This 6-bit subfield (81-86) shall contain the most recent estimated bearing of the threat aircraft, relative to the ACAS aircraft heading.

> *Coding (n)*
> *n*   *Estimated bearing (degrees)*
> 0   No bearing estimate available
> 1-60   Between $6(n-1)$ and $6n$
> 61-63   *Not assigned*

4.3.8.4.2.2.2.10   *DSI (designation indicator).* This 1-bit subfield (87) shall be coded as follows:

> *Coding*
> 0   The threat defined in TID is not designated for Xo or the designation is not applied
> 1   The threat defined in TID is designated for Xo, and the designation is applied

4.3.8.4.2.2.2.11   *SPI (suppression indicator).* This 1-bit subfield (88) shall be coded as follows:

For single-threat encounters:

> *Coding*
> 0   The RA is not suppressed
> 1   The RA is suppressed (not announced to the flight crew)

For multi-threat encounters, suppression does not apply, so the SPI subfield shall indicate the following designations:

18

Coding
0   No threat other than the one defined in TID is designated for Xo
1   Another threat is designated for Xo, and the designation is applied

Note.— For ACAS X compliant systems: Subfields in MB for an RA report.

33	37	41	51	53	55	59	60	61	62	63	74	81	87	88
BDS1 = 3	BDS2 = 0	ARA	LDI	RMF	RAC	RAT	MTE	CNT	TTI = 0	TIDA	TIDR	TIDB	DSI	SPI
36	40	50	52	54	58	59	60	61	62	73	80	86	87	88

33	37	41	51	53	55	59	60	61	62	63	87	88
BDS1 = 3	BDS2 = 0	ARA	LDI	RMF	RAC	RAT	MTE	CNT	TTI = 1	TID	DSI	SPI
36	40	50	52	54	58	59	60	61	62	86	87	88

4.3.8.4.2.2.3~~2~~   *Subfields in MB for the data link capability report.* When BDS1 = 1 and BDS2 = 0, the following bit patterns shall be provided to the transponder for its data link capability report:

Bit	Coding	
43-46	0000	TCAS Version 7.1 compliant and other systems defined by bits 71 and 72
	0001	ACAS Xa (RTCA/DO-385 and EUROCAE/ED-256)
	0010 to	
	1111	Reserved for ACAS III
48	0	ACAS failed or on standby
	1	ACAS operating
69	0	Hybrid surveillance not operational
	1	Hybrid surveillance fitted and operational
70	0	ACAS generating TAs only
	1	ACAS generating TAs and RAs

Bit 72	Bit 71	ACAS version
0	0	RTCA/DO-185 (pre-ACAS)
0	1	RTCA/DO-185A
1	0	RTCA/DO-185B and EUROCAE/ED-143
1	1	All later systems ~~Reserved for future versions~~ (see Note 3 and 4.3.8.4.2.8)

Note 1.— A summary of the MB subfields for the data link capability report structure is described in Chapter 3, 3.1.2.6.10.2.2.

Note 2.— The use of hybrid surveillance to limit ACAS active interrogations is described in 4.5.1. The ability only to support decoding of DF = 17 extended squitter messages is not sufficient to set bit 69.

Note 3.— Future versions of ACAS will be identified using part numbers and software version numbers specified in registers $E5_{16}$ and $E6_{16}$.

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4.3.8.4.2.3.2.1   *MTB (multiple threat bit).* This 1-bit (42) subfield shall indicate the presence or absence of multiple threats.

Coding
0   Interrogating ACAS has not more than one threat
1   Interrogating ACAS has more than one threat

...

4.3.8.4.2.3.4   *Subfields in MU for an RA broadcast (RA broadcast interrogation message)*

Note. — 4.3.8.4.2.3.4.1 is only applicable to TCAS Version 7.1 compliant systems, while 4.3.8.4.2.3.4.2 is only applicable to ACAS X compliant systems.

4.3.8.4.2.3.4.1   *For TCAS Version 7.1 compliant systems: Subfields in MU for an RA broadcast (RA broadcast interrogation message).* When UDS1 = 3 and UDS2 = 1, the following subfields shall be contained in MU:

4.3.8.4.2.3.4.1.1   *ARA (active RAs).* This 14-bit (41-54) subfield shall be coded as defined in 4.3.8.4.2.2.1.1.

4.3.8.4.2.3.4.1.2   *RAC (RACs record).* This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.1.2.

4.3.8.4.2.3.4.1.3   *RAT (RA terminated indicator).* This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.1.3.

4.3.8.4.2.3.4.1.4   *MTE (multiple threat encounter).* This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.1.4.

4.3.8.4.2.3.4.1.5   *AID (Mode A identity code).* This 13-bit (63-75) subfield shall denote the Mode A identity code of the reporting aircraft.

...

4.3.8.4.2.3.4.1.6   *CAC (Mode C altitude code).* This 13-bit (76-88) subfield shall denote the Mode C altitude code of the reporting aircraft.

...

4.3.8.4.2.3.4.2   *For ACAS X compliant systems: Subfields in MU for an RA broadcast (RA broadcast interrogation message). When UDS1 = 3 and UDS2 = 1, the follow*ing subfields shall be contained in MU:

4.3.8.4.2.3.4.2.1   *ARA (active RAs).* This 10-bit (41-50) subfield shall be coded as defined in 4.3.8.4.2.2.2.1.

4.3.8.4.2.3.4.2.2   *LDI (low-level descend inhibit).* This 2-bit (51-52) subfield shall be coded as defined in 4.3.8.4.2.2.2.2.

4.3.8.4.2.3.4.2.3   *RMF (RA message format).* This 2-bit (53-54) subfield shall be coded as defined in 4.3.8.4.2.2.2.3.

4.3.8.4.2.3.4.2.4   *RAC (RACs record).* This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.2.4.

4.3.8.4.2.3.4.2.5   *RAT (RA terminated indicator).* This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.2.5.

4.3.8.4.2.3.4.2.6   *MTE (multiple threat encounter).* This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.2.6.

4.3.8.4.2.3.4.2.7   *SPI (Suppression indicator).* This 1-bit (61) subfield shall be coded as defined in 4.3.8.4.2.2.2.11.

4.3.8.4.2.3.4.2.8   *AID (Mode A identity code).* This 13-bit (63-75) subfield shall denote the Mode A identity code of the reporting aircraft.
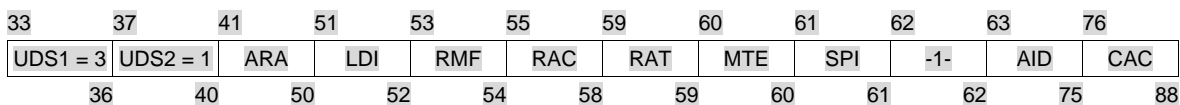
Coding

Bit	63	64	65	66	67	68	69	70	71	72	73	74	75
Mode A code bit	A_4	A_2	A_1	B_4	B_2	B_1	0	C_4	C_2	C_1	D_4	D_2	D_1

4.3.8.4.2.3.4.2.9   *CAC (Mode C altitude code).* This 13-bit (76-88) subfield shall denote the Mode C altitude code of the reporting aircraft.

Coding

Bit	76	77	78	79	80	81	82	83	84	85	86	87	88
Mode C code bit	C_1	A_1	C_2	A_2	C_4	A_4	0	B_1	D_1	B_2	D_2	B_4	D_4

Note. — Structure of MU for an RA broadcast:

33	37	41	51	53	55	59	60	61	62	63	76
UDS1 = 3	UDS2 = 1	ARA	LDI	RMF	RAC	RAT	MTE	SPI	-1-	AID	CAC
36	40	50	52	54	58	59	60	61	62	75	88

. . .

4.3.8.4.2.4.2   *Subfields in MV for a coordination reply*

Note. — 4.3.8.4.2.4.2.1 is only applicable to TCAS Version 7.1 compliant systems, while 4.3.8.4.2.4.2.2 is only applicable to ACAS X compliant systems.

4.3.8.4.2.4.2.1   *For TCAS Version 7.1 compliant systems: Subfields in MV for a coordination reply.* When VDS1 = 3 and VDS2 = 0, the following subfields shall be contained in MV:

4.3.8.4.2.4.2.1.1   *ARA (active RAs).* This 14-bit (41-54) subfield shall be coded as defined in 4.3.8.4.2.2.1.1.

4.3.8.4.2.4.2.1.2   *RAC (RACs record).* This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.1.2.

4.3.8.4.2.4.2.1.3   *RAT (RA terminated indicator).* This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.1.3.

4.3.8.4.2.4.2.1.4   *MTE (multiple threat encounter).* This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.1.4.

. . .

4.3.8.4.2.4.2.2   *For ACAS X compliant systems: Subfields in MV for a coordination reply.* When VDS1 = 3 and VDS2 = 0, the following subfields shall be contained in MV:

4.3.8.4.2.4.2.2.1   *ARA (active RAs).* This 10-bit (41-50) subfield shall be coded as defined in 4.3.8.4.2.2.2.1.

4.3.8.4.2.4.2.2.2   *LDI (low-level descend inhibit).* This 2-bit (51-52) subfield shall be coded as defined in 4.3.8.4.2.2.2.2.

4.3.8.4.2.4.2.2.3   *RMF (RA message format).* This 2-bit (53-54) subfield shall be coded as defined in 4.3.8.4.2.2.2.3.

4.3.8.4.2.4.2.2.4   *RAC (RACs record).* This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.2.4.

4.3.8.4.2.4.2.2.5   *RAT (RA terminated indicator).* This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.2.5.

4.3.8.4.2.4.2.2.6   *MTE (multiple threat encounter).* This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.2.6.

Note. — Structure of MV for a coordination reply:

33	37	41	51	53	55	59	60	61	
VDS1 = 3	VDS2 = 0	ARA	LDI	RMF	RAC	RAT	MTE	Not assigned.	
36	40	50	52	54	58	59	60		88

4.3.8.4.2.5   *SL (sensitivity level report).* This 3-bit (9-11) downlink field shall be included in both short and long air-air reply formats (DF = 0 and 16). This field shall denote the sensitivity level at which ACAS is currently operating.

Coding
0   ACAS inoperative
1   ACAS is operating at sensitivity level 1
2   ACAS is operating at sensitivity level 2
3   ACAS is operating at sensitivity level 3
4   ACAS is operating at sensitivity level 4
5   ACAS is operating at sensitivity level 5
6   ACAS is operating at sensitivity level 6
7   ACAS is operating at sensitivity level 7

Note. — For ACAS X compliant systems: ACAS will not transmit an SL code greater than 3.

…

4.3.8.4.2.7   *For ACAS X compliant systems: Extended squitter ME field for use in air-to-air coordination.* This 56-bit (33-88) field shall be used for air-to-air coordination involving ADS-B only equipped intruders (intruders that cannot receive a discrete 1 030 MHz resolution message).

Note. — ADS-B messages with TYPE code = 28 (ADS-B operational coordination message, refer to 4.3.8.4.2.7.1) and TYPE code = 31 (ADS-B aircraft operational status message, refer to 4.3.8.4.2.7.2) are used in air-to-air coordination.

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4.3.8.4.2.7.1   *Subfields in ME for ADS-B operational coordination message (OCM).*

Note. — In the subfields defined below, the bit number is relative to the start of the extended squitter, where bit 33 is the start of the ME message field.

4.3.8.4.2.7.1.1   *TYPE.* This 5-bit (33-37) subfield that defines the type of extended squitter shall be set to 28 for the ADS-B OCM.

4.3.8.4.2.7.1.2   *Subtype.* This 3-bit (38-40) subfield that further defines TYPE shall be set to 3 for the ADS-B OCM.

4.3.8.4.2.7.1.3   *MTB (multiple threat bit).* This 1-bit (42) subfield shall indicate a multiple threat according to the codes as defined in 4.3.8.4.2.3.

4.3.8.4.2.7.1.4   *CVC (cancel vertical RAC).* This 2-bit (43-44) subfield shall be used by airborne ACAS X equipment to cancel a vertical resolution advisory complement sent to an ACAS equipped threat aircraft with codes as defined in 4.3.8.4.2.3.

4.3.8.4.2.7.1.5   *VRC (vertical RAC).* This 2-bit (45-46) subfield shall be used by airborne ACAS X equipment to send a vertical resolution advisory complement ("do not pass above" or "do not pass below") to an ACAS equipped threat aircraft with codes as defined in 4.3.8.4.2.3.

4.3.8.4.2.7.1.6   *CHC (cancel horizontal RAC).* This 3-bit (47-49) subfield shall be used by ACAS X with horizontal on-board resolution equipment to cancel a horizontal resolution advisory complement sent to an ACAS equipped threat aircraft with codes as defined in 4.3.8.4.2.3. The CHC shall be set to 0 in TCAS resolution messages transmitted by ACAS X without horizontal resolution capability.

4.3.8.4.2.7.1.7   *HRC (horizontal RAC).* This 3-bit (50-52) subfield shall be used by ACAS X with horizontal on-board resolution equipment to send a horizontal resolution advisory complement to manoeuvre ("do not turn left" or "do not turn right") to the ACAS equipped threat aircraft with codes as defined in 4.3.8.4.2.3. The HRC shall be set to 0 in ADS-B OCMs transmitted by ACAS X without horizontal resolution capability.

4.3.8.4.2.7.1.8   *HSB (horizontal sense bits subfield).* This 5-bit (53-57) subfield shall be used as a parity coding field to protect the six horizontal sense bits (47-52). The originating aircraft equipped with ACAS which is capable of 1 030/1 090 MHz transmission and that sends a coordination message shall include bits 53-57 with code as defined in 4.3.8.4.2.3 in all ADS-B OCMs sent. The receiving ACAS X aircraft shall examine HSB (bits 53-57) in the ADS-B OCMs. If the six vertical sense bits (47-52) are not in agreement with the HSB (bits 53-57), the receiving ACAS X aircraft detects there is an error in the message and shall not use the message contents.

4.3.8.4.2.7.1.9   *VSB (vertical sense bits subfield).* This 4-bit (58-61) subfield shall be used as a parity coding field to protect the four vertical sense bits (43-46). The originating active ACAS shall include VSB (bits 58-61) with codes as defined in 4.3.8.4.2.3 in all operational coordination messages sent. The receiving ACAS X shall examine VSB (bits 58-61) in operational coordination messages received. If four vertical sense bits (43-46) are not in agreement with VSB (bits 58-61), the receiving ACAS X aircraft detects there is an error in the message and shall not use the message contents.

4.3.8.4.2.7.1.10   *TAA (threat identity aircraft address).* This 24-bit (65-88) subfield shall contain the 24-bit aircraft address of the threat with codes as defined in 4.3.8.4.2.3.

Note. —The structure of ME for an operational coordination message is:

Position	# of bits	Subfield	Remarks
33-37	5	TYPE	= 28
38-40	3	Subtype	= 3
41	1	-	Not assigned
42	1	MTB	-
43-44	2	CVC	-
45-46	2	VRC	-
47-49	3	CHC	-
50-52	3	HRC	-
53-57	5	HSB	-
58-61	4	VSB	-
62-64	3	-	Not assigned
65-88	24	TAA	-

4.3.8.4.2.7.2   *Subfields in ME for* aircraft operational status message.

Note. — In the subfields defined below, the bit number is relative to the start of the extended squitter, where bit 33 is the start of the ME message field.

4.3.8.4.2.7.2.1   *TYPE.* This 5-bit (33-37) subfield that defines the type of extended squitter shall be set to 31 for the Aircraft operational status message.

4.3.8.4.2.7.2.2   *Subtype.* This 3-bit (38-40) subfield that further defines TYPE shall be set to 0 for airborne aircraft and 1 for surface aircraft. For ACAS X air-to-air coordination purposes, Subtype shall always be set to 0.

4.3.8.4.2.7.2.3   *CC (airborne capability class code).*This 16-bit (41-56) subfield which is part of Subtype=0 messages shall be coded as defined in 4.3.8.4.2.7.2.3.1 to 4.3.8.4.2.7.2.3.4.

4.3.8.4.2.7.2.3.1   *Bit (41-42).* This 2-bit (41-42) subfield shall be set to 0 for ACAS air-to-air coordination purposes.

4.3.8.4.2.7.2.3.2   *CA Operational (collision avoidance operational).* This 1-bit (43) subfield shall be set to 1 to indicate that a collision avoidance system is available and operational and capable of issuing resolution advisories. When this bit is set to 1, the collision avoidance coordination capability bits shall be examined to provide detailed coordination information.

Note. — For all TCAS II versions and ACAS X compliant systems, the associated Mode S transponder sets the CA Operational bit=1 when RI=3 or 4.

4.3.8.4.2.7.2.3.3   Bits (44-54) shall not be used by the ACAS X air-to-air coordination process but are reserved for future use.

4.3.8.4.2.7.2.3.4   *DAA (detect and avoid).* This 2-bit (55-56) subfield shall be used as defined below:

00	No DAA capability or no capability of DAA system to receive CA coordination information
01	Aircraft has a DAA system capable of receiving TCAS resolution messages and ADS-B OCMs
10	Aircraft has a DAA system capable of receiving only ADS-B OCMs
11	Not defined

Note 1. — The DAA bits indicate whether and what type of coordination information needs to be

provided to the aircraft so that the DAA system of the threat aircraft can listen and provide guidance that is interoperable with ACAS. These bits are independent of the CA Coordination capability bits, as aircraft with a DAA system may or may not have an ACAS .For more details of DAA bits, refer to RTCA/DO-365.

   Note 2. — The type of coordination message transmitted, resolution message or ADS-B OCM, depends both on the receive capability of the DAA system and on the transmit capability of the ACAS. If the DAA system can receive both the resolution message and the OCM, an ACAS with 1 030 MHz transmit capability is required to transmit the resolution message.

4.3.8.4.2.7.2.4   *OM (airborne operational mode).* This 16-bit (57-72) subfield which is part of Subtype=0 messages shall be coded as defined in 4.3.8.4.2.7.2.4.1 to 4.3.8.4.2.7.2.4.3.

4.3.8.4.2.7.2.4.1   *Bits (57-58).* This 2-bit (57-58) subfield shall be set to 0 for ACAS X air-to-air coordination purposes.

4.3.8.4.2.7.2.4.2   *Bits (59-64) and Bit 72.* The bits (59-64) and bit 72 shall not be used by the ACAS X air-to-air coordination process.

4.3.8.4.2.7.2.4.3   *CCCB (collision avoidance coordination capability bits).* This 7-bit (65-71) subfield shall be used as defined below:

Vertical and horizontal (2 bits (65-66))

00	Vertical
01	Horizontal
10	Blended
11	Reserved

Aircraft CAS Type / Capability (3 bits (67-69))

000	Active ACAS (TCAS II)
001	Active ACAS (except all TCAS II)
010	Active ACAS (except all TCAS II) with OCM transmit capability
011	Responsive ACAS
100	Passive ACAS with 1 030 MHz resolution message receive capability
101	Passive ACAS with only OCM receive capability
110 to 111	Reserved

Reserved (2 bits (70-71))

00 to 11	Intended for unmanned aircraft systems use

   Note. — The two reserved bits marked 'Intended for unmanned aircraft systems use' are envisioned as a priority field to distinguish among users with different levels of capability or as directed by regulatory authorities.

4.3.8.4.2.8   *ACAS unit part number and ACAS software part number.* If the ACAS and associated transponder have the necessary capacity, ACAS shall transmit its unit part number to transponder register $E5_{16}$ and shall transmit its software part number to transponder register $E6_{16}$.

   Note. — The data formats for transponder registers $E5_{16}$ and $E6_{16}$ are specified in the Technical Provisions for Mode S Services and Extended Squitter *(Doc 9871).*

4.3.9   ACAS equipment characteristics

4.3.9.1   *Interfaces.* As a minimum, the following input data shall be provided to the ACAS:

a)   aircraft address code;

b)   air-air and ground-air Mode S transmissions received by the Mode S transponder for use by ACAS (4.3.6.3.2);

c)   own aircraft's maximum cruising true airspeed capability (Chapter 3, 3.1.2.8.2.2);

d)   pressure-altitude; ~~and~~

e)   radio altitude;

f)   operating mode control (standby, TA only and TA/RA Mode);

g)   for ACAS X compliant systems: heading;

h)   for ACAS X compliant systems: GNSS own aircraft's position and velocity;

i)   for ACAS X compliant systems: ADS-B airborne and surface position, airborne velocity, target state and status, and aircraft operational status messages from other aircraft for use by ACAS; and

j)   for ACAS X-compliant systems with Xo special modes available: Designation information for special operation mode.

Note. — Specific requirements for additional inputs for ACAS II and III are listed in the appropriate sections below.

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4.3.11   Requirements for a Mode S transponder
used in conjunction with ACAS

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4.3.11.2.2   Data transfer from Mode S transponder to its ACAS:

a)   For TCAS Version 7.1 compliant systems: The Mode S transponder shall transfer to its ACAS received sensitivity level control commands (4.3.8.4.2.1.1) transmitted by Mode S stations;

b)   the Mode S transponder shall transfer to its ACAS received ACAS broadcast messages (4.3.8.4.2.3.3) transmitted by other ACASs;

c)   the Mode S transponder shall transfer to its ACAS received resolution messages (4.3.8.4.2.3.2) transmitted by other ACASs for air-air coordination purposes; and

d)   the Mode S transponder shall transfer to its ACAS own aircraft's Mode A identity data for transmission in an RA broadcast (4.3.8.4.2.3.4.5).

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4.4   PERFORMANCE OF THE ACAS II COLLISION AVOIDANCE LOGIC

Note 1. — Caution is to be observed when considering potential improvements to ~~the reference ACAS II system described in Section 3.17 of the~~ Airborne Collision Avoidance System (ACAS) Manual ~~(Doc 9863)~~ ACAS since changes may affect more than one aspect of the system performance. It is essential that alternative designs would not degrade the performance~~s~~ of other designs and that such compatibility is demonstrated with a high degree of confidence. The performance specified in Section 4.4 is based on the performance achieved by TCAS Version 7.1 compliant systems.

Note 2. — The performance of ACAS X compliant systems is improved compared to the performance of TCAS Version 7.1 compliant systems. For more information, refer to the Airborne Collision Avoidance System (ACAS) Manual (Doc 9863).

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4.5.1   ACAS hybrid surveillance using extended squitter position data

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4.5.1.6   *Full active surveillance.* If the following condition is met for a track being updated via passive surveillance data:

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4.5.1.6.1   All near threats, potential threats and threats shall be tracked using active surveillance.

4.5.1.6.2   Adequate protection against residual ADS-B position data shall be provided in track state computation when transitioning from passive to active surveillance, in order to avoid unnecessary advisories during such transitions.

Note.— A suitable means of protection can be found in RTCA DO-300 Change 2 *and* RTCA DO-300A Change 1/EUROCAE ED-221A – Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance*, Section 2.2.6.2.*

4.5.1.6.~~2~~3   A track under active surveillance shall transition to passive surveillance if it is neither a near threat, potential threat nor a threat. The tests used to determine it is no longer a near threat shall be similar to those used in 4.5.1.4 but with larger thresholds in order to have hysteresis which prevents the possibility of frequent transitions between active and passive surveillance.

Note.— Suitable tests for determining that an intruder is no longer a near threat can be found in RTCA DO-300A Change 1/EUROCAE ED-221A – Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance.

— END —