



The European Organisation for Civil Aviation Equipment
L'Organisation Européenne pour l'Équipement de l'Aviation Civile

MINIMUM OPERATIONAL PERFORMANCE STANDARDS FOR TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM II (TCAS II) Version 7.1

Change 2

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FOREWORD

1. This document was prepared jointly by EUROCAE Working Group 75 "Traffic Collision Avoidance System (TCAS)" and RTCA SC-147 "Traffic Alert & Collision Avoidance System (TCAS)", and was approved by the Council of EUROCAE on 10 April 2013.
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5. Change 2 to ED-143/DO-185B provides for the following five (5) changes:
 1. Improve the efficiency of the TCAS surveillance function so as to reduce utilization of the 1030 and 1090 MHz channel without reducing the effectiveness of the equipment's collision avoidance function.
 2. Allow TCAS to implement a narrow band Mode S receive function compatible with the RTCA/DO-260B ADS-B receiver requirements without negatively impacting the TCAS receiver function.
 3. Update the flight test requirements to add Atlanta as an alternate location for high density Mode S flight testing and to modify the combined air and ground density requirement accordingly.
 4. Decrease the TCAS RA broadcast interval from 8 seconds to 1 second to be compatible with the intended use of this data by ground controllers.
 5. Clarify the intent of interference limiting by adding text to the requirements and adding a new test.
6. Copies of this document may be obtained from:

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CHAPTER 1

CHANGES TO VOLUME I

- (1.1) The following changes to §2.2.2, §2.2.3.6.3, §2.2.4.6.2.2.1, §2.2.4.6.2.2.2, §2.4.4 (Tables 2-69 and 2-70), and creation of §2.4.2.1.7.4.4 reduce TCAS 1030 and 1090 MHz channel utilization. Specifically it reduces unnecessary TCAS interrogations when operating on the airport surface. These changes reduce initial TCAS interrogation power by 10 dB when TCAS is powered-on, and ensures that TCAS aircraft on the ground do not interrogate other on-ground TCAS aircraft while maintaining proper NTA3 and NTA6 counts for TCAS aircraft approaching an airport. The Mode S surveillance volume is also limited to ± 3000 feet while the TCAS unit is operating on the ground. Any proposed new text will be highlighted in gray while text intended to be deleted will be marked with red ~~strikethrough~~ font.

2.2.2 System Performance

NOTE: *When operating within the maximum aircraft transponder population and electromagnetic interference levels defined in subparagraph 2.2.1.2, TCAS II will provide a level of performance for active surveillance of targets-of-interest that will support the requirements for generation of collision advisory information.*

Specifically, TCAS II will generate a surveillance track in range and altitude on a target-of-interest at the range and with the track probability and range accuracy specified below. This is to ensure that a correct resolution advisory can be issued in time for the pilot to maintain adequate vertical separation at closest-point-of-approach.

TCAS II will also generate, whenever possible, a surveillance track in range and altitude on a target-of-interest at the range and with the track probability and range accuracy specified below such that a correct traffic advisory can be issued as a precursor to the resolution advisory.

In addition to the surveillance requirements to support generation of resolution and traffic advisories, TCAS II will display the range and, if available, the altitude and bearing position information on targets that generate advisories. The bearing position information will be generated according to the accuracy requirement specified below.

TCAS II will also generate for display, whenever possible, surveillance range, altitude and bearing position information on Mode C and Mode S aircraft that are within the range specified below and within $\pm 10,000$ ft altitude relative to TCAS II when airborne, and within $\pm 3,000$ ft altitude relative to TCAS II when on the ground.

2.2.3.6.3 Interrogations From TCAS on the Ground

Whenever the TCAS aircraft determines that it is on the ground, TCAS interrogations shall be limited by setting the *NTA* count in the interference limiting inequalities to a value three times the measured value. This value will ensure that a TCAS operating on the ground does not add unnecessary interference by transmitting at power levels greater than is necessary to provide local area surveillance prior to departure. The modified value of *NTA* will provide an approximate surveillance range of 3 NM in the highest density terminal areas to support reliable ground TCAS surveillance of local airborne traffic and a 14 NM range in very low density airspace to provide wide area surveillance in the absence of an SSR. When TCAS transitions from standby to TA or TA/RA mode and the TCAS aircraft determines that it is on the ground, it shall initialize to the maximum allowed airborne interference limiting values, 10 dB attenuation for Mode S interrogations and 7 dB for Mode C interrogations.

2.2.4.6.2.2.1 Squitter Processing

To reduce the number of unnecessary interrogations, no interrogations shall be transmitted to a target if so few squitters and altitude replies are received from it to indicate an unreliable RF link. Also, the equipment shall not interrogate for acquisition a target whose altitude ~~is determined from DF=0 or DF=4 replies or continue to interrogate for acquisition a target whose altitude is determined by an active interrogation unless the altitude information indicates that it is within $\pm 10,000$ ft of own altitude~~ information indicates that it is not within $\pm 10,000$ ft of own altitude when own aircraft is airborne or not within $\pm 3,000$ ft of own altitude when own aircraft is on the ground. Targets that are within $\pm 10,000$ ft of own altitude when TCAS II is airborne, or within $\pm 3,000$ ft of own altitude when TCAS II is on the ground, and that indicate a reliable RF link are called valid targets. In order to provide timely acquisition of targets that transition the altitude surveillance boundary, the altitude of targets that are indicated to be outside of $\pm 10,000$ ft of own altitude when TCAS II is airborne, or outside of $\pm 3,000$ ft of own altitude when TCAS II is on the ground, shall continue to be monitored using DF=0 or DF=4 replies or, in the absence of such replies, by interrogating once every 10 seconds.

2.2.4.6.2.2.2 Acquisition

When a valid acquisition reply is received, the VS field in the reply shall be used to determine whether the aircraft is on the ground as described in 2.2.4.6.1.3. Mode S aircraft that are determined to be on the ground ~~according to the VS field~~ shall be monitored ~~either~~ passively with replies (DF=0 or ~~DF=4~~) or squitters (CA field of DF=11 or 17). ~~replies or by actively interrogating.~~ In the absence of passive monitoring, an active interrogation once every five surveillance update intervals shall be used to monitor the air/ground status as long as the aircraft remains on the ground and continues to transmit squitters. In addition, if own aircraft is airborne and at or below 2000 feet AGL, the range of Mode S aircraft that are determined to be both on the ground, according to the VS field, and TCAS-equipped, according to the TCAS Broadcast Interrogations, shall be measured by using ~~the an~~ active interrogation once every five surveillance ~~update~~ intervals. Monitored information shall not be made available to the CAS logic.

2.4.4 Cross-Reference of Requirements and Associated Tests

Add the following rows to Table 2-69:

Tests		Requirements	
2.4.2.1.7.4.4	Mode S Surveillance Special Functionality Test	2.2.3.6.1	Interference Limiting Formulas
		2.2.3.6.3	Interrogations From TCAS On The Ground
		2.2.4.6.2.2.1	Squitter Processing
		2.2.4.6.2.2.2	Acquisition

Add the following rows to Table 2-70:

Requirements		Tests	
2.2.3.6.1	Interference Limiting Formulas	2.4.2.1.7.4.4	Mode S Surveillance Special Functionality Test
2.2.3.6.3	Interrogations From TCAS On The Ground		
2.2.4.6.2.2.1	Squitter Processing		
2.2.4.6.2.2.2	Acquisition		

2.4.2.1.7.4.4 Surveillance Special Functionality Test

This test will verify that TCAS is designed to:

- a. Initialize interference limiting at 10dB power attenuation for Mode S surveillance and 7dB for Mode C surveillance when powered on while on the ground, §2.2.3.6.3
- b. Limit acquisition of targets to those within an altitude of +/- 3000 feet relative to TCAS when operating on the ground, §2.2.4.6.2.2.1 and §2.2.4.6.2.2.2
- c. Properly interrogate TCAS targets on the ground when own aircraft is airborne and at or below 2000 feet AGL and set NTA3 and NTA6 appropriately, §2.2.3.6.1 and §2.2.4.6.2.2.2

Inputs

TCAS Aircraft

Altitude / Radio Altitude	= 0 ft at T=0 seconds
Altitude Rate	= 0 FPM at T=0 seconds
	= 1000 FPM at T=45 seconds
	(gradual acceleration to 1000 FPM permitted)
On Ground	= TCAS on ground at T=0 seconds
In Air	= TCAS in-air after T=45 seconds
Sensitivity Level Selection	= Set to standby before T=0,
	Set to TA/RA (Automatic) at T=0.

Intruder Aircraft 1

Equipage	= TCAS II
Altitude	= 0 ft
Altitude Rate	= 0 FPM
Range	= 0.2 NM at T=0 seconds
Relative Speed	= 0 kt at T=0 seconds
	= 200 kt at T=45 Seconds

Intruder Aircraft 2-6

Equipage	= Mode S
Altitude	= 500 - 4500 ft in 1000 ft increments
Altitude Rate	= 0 FPM
Range	= 15 NM
Squitter Power	= -68 dBm
Relative Speed	= 0 kt

Conditions

TCAS initialized and operating at T=0 seconds.

Scenario Description

TCAS initializes to 10dB attenuation on interrogation power and squitter reception sensitivity.

Success: TCAS does not send acquisition interrogations to targets 2-4 until T=17 seconds and should send acquisition interrogations no later than T=33 seconds. Verify that the Mode C interrogation sequence power/steps has been reduced by 7dB at the start of the test. Verify that by T=81, the Mode C interrogation sequence power/steps has been restore to full power.

TCAS does not interrogate targets for acquisition outside +/- 3000 ft of own altitude when on the ground.

Success: TCAS does not send acquisition interrogations to targets 5-6 before T=45 seconds.

TCAS properly interrogates TCAS targets on the airport surface and sets NTA3 and NTA6 appropriately.

Success: TCAS does not send range monitoring interrogations to target 1 before T=45 seconds (because own aircraft is on the ground). NTA6=0 from T=0 to 44 seconds; NTA6=1 from T=45 to 152 seconds; NTA6=0 after T=153 seconds. NTA3=0 from T=0 to 44 seconds; NTA3=1 from T=45 to 98 seconds; NTA3=0 after T=99 seconds. Range monitoring interrogations to target 1 shall not be sent after T=165 seconds. The NTA numbers expected above can transition up to 5 seconds later than specified above.

- (1.2) The following changes to §2.2.4.4.1 and §2.4.2.1.2.1.1 allow implementation of a narrow band (± 1 MHz) receiver to accommodate a shared TCAS/ADS-B receiver compatible with RTCA/DO-260B without degradation of required TCAS surveillance performance. Any proposed new text will be highlighted in gray while text intended to be deleted will be marked with red ~~strikethrough~~ font.

2.2.4.4.1 Receiver Sensitivity And Bandwidth

2.2.4.4.1.1 In-Band Acceptance

Given a valid transponder reply signal in the absence of interference or overloads, the minimum trigger level (MTL) is defined as the minimum input power level that results in a 90% ratio of decoded to received replies.

- a. The MTL for ATCRBS signals over the frequency range of 1087 to 1093 MHz shall be $-74 \text{ dBm} \pm 2 \text{ dB}$.

The MTL for Mode S signals over the frequency range of 1089 to 1091 MHz shall be $-74 \text{ dBm} \pm 2 \text{ dB}$.

NOTE: This provides adequate link margin for reliable detection of near-co-altitude aircraft in level flight at a range of 14 NM.

NOTE: To accommodate a shared TCAS/ADS-B receiver, a narrow band (1089 to 1091 MHz) receiver for Mode S signals is acceptable.

- b. For an input signal power level of -78 dBm or less, no more than 10% of ATCRBS and Mode S signals shall be decoded.
- c. The decoding ratio shall be at least 99% for ATCRBS and Mode S signals between MTL $+3 \text{ dB}$ and -21 dBm

2.4.2.1.2.1 In-Band Acceptance (2.2.4.4.1.1)

2.4.2.1.2.1.1 Ability to Operate Over the Frequency Band 1087 to 1093 MHz for ATCRBS and 1089 to 1091 MHz for Mode S Signals

These tests verify the ability of the TCAS Receiver to operate over the frequency band 1087 to 1093 MHz for ATCRBS signals and also over the frequency band of 1089 to 1091 MHz for Mode S signals.

If the antenna gain is not as specified in subparagraph 2.2.4.7.2, each of the reply power levels specified in the tests shall be adjusted to compensate for the difference between the specified antenna gain and the actual antenna gain. For example, if the antenna gain is three dB below the specified value, each of the reply power levels specified in the test shall be lowered by three dB.

Mode C Tests

(No change)

Mode S Tests

Inputs

As described in 2.4.2.1.2 and supplemented as follows:

Intruder Aircraft

Equipage	=	Mode S
Squitter Frequency		
Scenario A	=	~~1087 MHz~~ 1089 MHz
Scenario B	=	~~1093 MHz~~ 1091 MHz
Squitter Power		
Scenario A	=	-72 dBm
Scenario B	=	-72 dBm