Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II) Airborne Equipment

Volume I

This document provides version 7.0 of the TCAS II logic and sets forth the minimum operational performance standards for TCAS II equipment. Among the changes, this version improves the system's surveillance performance and modifies the interference limiting algorithms to account for aircraft densities near airports as well as to permit longer range surveillance. Improvements have been made in tracking Mode S targets and in permitting TCAS to receive the extended Mode S squitter. To preclude repeatedly issuing Traffic Advisories (TA) against the same target, changes have been made to ensure that a target's TA status is maintained in slow closure situations by using more stringent drop criteria. Other changes include credibility checks to ensure integrity of the data being supplied to the collision avoidance logic and additional, more thorough tests for installed equipment.

Volume I contains the rationale for equipment characteristics, minimum performance standards, bench test procedures, and installed equipment performance.

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1.0 PURPOSE AND SCOPE

1.1 Introduction

This document sets forth minimum operational performance standards for Traffic Alert and Collision Avoidance System II (TCAS II) equipment.

Note: *There are three members of the TCAS family. TCAS I is a pilot warning indicator which displays proximate traffic and alerts the crew to other aircraft which may become potential near midair collision threats. TCAS II in addition provides recommended vertical escape maneuvers to the crew to avert potential near midair collisions. TCAS IV is proposed TCAS equipment that has additional capabilities beyond those of TCAS II equipment to generate resolution advisories in the horizontal plane (e.g., "TURN RIGHT," "TURN LEFT"). The equipment described by this document does not have horizontal resolution capability. In this document, TCAS I is denoted "TCAS I"; the use of the unqualified term "TCAS" refers exclusively to TCAS II; and TCAS IV either is explicitly denoted "TCAS IV" or is implicitly denoted together with TCAS II by the qualifying language "TCAS with a resolution advisory generating capability".*

TCAS provides a reliable aircraft separation assurance function in traffic densities as high as 0.3 aircraft per square nautical mile (24 transponder-equipped aircraft within five nautical miles of the TCAS-equipped aircraft).

When TCAS operates in traffic densities of 0.3 transponder-equipped aircraft per square nautical mile or higher, it provides protection against collisions with other aircraft that are closing at speeds of less than 500 kt. TCAS is also capable of providing protection against aircraft closing at relative speeds of up to 1200 kt in airspace characterized by densities of less than 0.06 transponder-equipped aircraft per square nautical mile, which is equivalent to eighteen transponder-equipped aircraft within ten nautical miles of the TCAS aircraft.

In addition to the minimum standards contained in this document, several options are described herein which will allow TCAS to request and/or receive information from other MODE S-equipped aircraft. These optional features provide for the exchange of information via the proposed MODE S extended squitter or an air to air data link. The purpose for including these options in this standard is to permit a uniform minimum capability to upgrade or enhance TCAS in the future. The specific applications for these optional features and the applications' corresponding minimum operational performance characteristics are not part of these standards.

Incorporated within these standards are system characteristics that should be of value to users, designers, manufacturers, and installers. These characteristics are intended to accommodate the requirements of various users.

This document is published in two volumes. Section 1.0 of Volume I is intended to provide information needed to understand the rationale for equipment characteristics and requirements stated in the remaining sections. It describes typical equipment applications and operational goals as envisioned by the members of Special Committee 147 and is the basis for the standards stated in the document. Definitions essential to proper understanding of this document are also provided in Section 1.0.

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Section 2.0 of Volume I contains the minimum performance standards for the equipment. These standards define the required performance under standard operating conditions and stressed physical environmental conditions. Section 2.0 includes as guidance material an overview of the TCAS collision avoidance algorithms. It also details the recommended bench test procedures necessary to demonstrate compliance, including specific bench tests for the collision avoidance logic performance.

Section 3.0 of Volume I describes the performance required of the installed equipment. Tests for the installed equipment are included when performance cannot be adequately determined through bench testing.

Volume II contains the required collision avoidance algorithms. The algorithms are presented in a state chart formulation with informational commentary text. In addition, Attachment A of Volume II contains both high and low level pseudocode representations of the collision avoidance algorithms which have been formally proven to be in accordance with the state chart formulation.

Both Volumes I and II contain certain standards and performance requirements that are intended to ensure that TCAS II is fully interoperable (see 1.7.5) with other elements and equipment of the National Airspace System. It is mandatory that all interoperability provisions be met without exception or deviation. Other technical and performance requirements stated herein that were derived from the particular implementation approach that formed the basis for the development of this MOPS may be waived if the manufacturer or installer provides evidence of equivalent system performance for an alternative method of implementation and if the alternative implementation does not violate interoperability provisions.

Since the measured values of equipment performance characteristics may be functions of the methods of measurement, standard test conditions and methods of test are recommended in this document.

"TCAS equipment" as used herein includes all components or units necessary (as determined by the manufacturer or installer) for the equipment to perform its function properly with the exception of the Mode S transponder. It should not be inferred that each TCAS equipment design will necessarily have all components or units in separate packages. This will depend on the specific design chosen by the manufacturer. The transponder capabilities may also be implemented as part of the TCAS avionics package but the term "TCAS equipment" will refer only to the TCAS portion of this package. Additional functions and components that may provide expanded equipment capabilities are identified. Other equipment features that are beyond the scope of this document may be described in future RTCA documents.

If the equipment implementation includes a computer software package, compliance with the guidelines contained in RTCA/DO-178B, Software Considerations in Airborne Systems and Equipment Certification, December 1, 1992, and all changes thereto is considered mandatory by the Federal Aviation Administration.

1.2 System Overview

The TCAS equipment in the aircraft interrogates air traffic control transponders on aircraft in its vicinity and listens for the transponder replies. By computer analysis of

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