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Minimum Operational Performance Standards (MOPS) for Electro-Optical/Infrared (EO/IR) Sensor Systems for Traffic Surveillance

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EXECUTIVE SUMMARY

This document contains Minimum Operational Performance Standards (MOPS) for Electro-Optical/Infrared (EO/IR) Sensors for Traffic Surveillance.

The EO/IR sensor system is a surveillance source for non-cooperative intruders for a Detect and Avoid (DAA) system used in Unmanned Aircraft Systems (UAS) transiting through Class B, C, D, E and G airspace and performing extended operations higher than 400' Above Ground Level (AGL) in Class D, E (up to Flight Level 180 (FL180)), and G airspace. It includes equipment to enable UAS operations in Terminal Areas during approach and departure in Class C, D, E and G airspace and off-airport locations. It does not apply to small UAS (sUAS) operating in low-level environments (below 400') or other segmented areas. Likewise, it does not apply to operations in the Visual Flight Rules (VFR) traffic pattern of an airport or to surface operations.

The intended function of the EO/IR sensor system is to detect and generate tracks for all airborne traffic within the EO/IR sensor system detection volume. The onboard EO/IR sensor system complements other airborne surveillance sensors by providing detection of non-cooperative traffic. The track should be established at sufficient range and with sufficient accuracy to enable the remote pilot to plan and execute a maneuver to keep the Unmanned Aircraft (UA) well clear of other traffic and avoid collisions.

This document has the detailed performance and environmental requirements of the EO/IR sensor system along with their verification methods. Verification includes bench tests, flight tests and environmental tests. Recommendations and flight tests for installed performance are also provided.

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1 Purpose And Scope

1.1 Introduction

This document contains Minimum Operational Performance Standards (MOPS) for Electro-Optical/Infrared (EO/IR) sensors for traffic surveillance.

The EO/IR sensor system is a surveillance source for non-cooperative intruders for a Detect and Avoid (DAA) system used in Unmanned Aircraft Systems (UAS) transiting through Class B, C, D, E, and G airspace and performing extended operations higher than 400' Above Ground Level (AGL) in Class D, E (up to Flight Level (FL180)), and G airspace. It includes equipment to enable UAS operations in Terminal Areas during approach and departure in Class C, D, E and G airspace and off-airport locations. It does not apply to small UAS (sUAS) operating in low-level environments (below 400') or other segmented areas. Likewise, it does not apply to operations in the Visual Flight Rules (VFR) traffic pattern of an airport or to surface operations.

These standards specify the characteristics of the EO/IR sensor system that should be useful for designers, manufacturers, installers and users of the equipment. Compliance with these standards is recommended as one means of assuring that the equipment will perform its intended function(s) satisfactorily under the conditions specified herein. Any regulatory application of this document is the sole responsibility of appropriate governmental agencies.

This document sets performance standards for EO/IR sensor systems for non-cooperative traffic surveillance as part of a DAA system. Separate MOPS were developed for the DAA system adapted to low-power ownship.[1] The RTCA MOPS for DAA Systems (hereafter referred to as the "DAA MOPS") refer to these MOPS (hereafter referred to as the "EO/IR sensor system MOPS" or "these MOPS") to satisfy surveillance requirements for non-cooperative intruders adapted to a low-power Unmanned Aircraft (UA). The basic functions of the EO/IR sensor system, e.g., Power On/Off, are controlled by the Remote Pilot in the Control Station (CS). Similarly, the EO/IR sensor system provides its status to the CS during operation. The CS sends commands to the EO/IR sensor system and receives status from it. Tracks generated by the EO/IR sensor system are sent to the DAA system for further processing.

Section 1 of this document provides information needed to understand the rationale for the equipment characteristics and requirements in Section 2. It describes typical equipment operations and operational goals as envisioned by the members of RTCA Inc. Special Committee (SC)-228, and establishes the basis for the standards stated herein. Definitions and assumptions essential to proper understanding of this document are also provided in this section.

Section 2 contains the performance requirements for the equipment. These standards specify the required performance under standard environmental conditions. Also included are recommended bench test procedures necessary to demonstrate equipment compliance with the stated minimum requirements.

Section 3 describes the performance required of installed equipment. Tests for the installed equipment are included when performance cannot be adequately determined through bench testing.

Section 4 contains aircraft operational performance characteristics.

[1] Minimum Operational Performance Standards (MOPS) for Detect and Avoid (DAA) Systems, RTCA DO-365B

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Section 5 contains an informative listing of SC-228 committee members who contributed to these MOPS.

Appendix A contains information on the proposed wavelengths for the EO/IR equipment.

Appendix B contains methods and results of analysis and simulations that derive the required minimum Declaration Ranges (DRs) for the EO/IR sensor system to alert the remote pilot to maneuver to remain Detect and Avoid (DAA) Well Clear (DWC) for different categories of intruders and different encounter geometries between the ownship and intruders. Analysis focuses on encounters with non-cooperative aircraft.

Appendix C provides methods and results of analysis on the frequency of cases where an intruder enters the EO/IR sensor system Field of Regard (FOR) within its Declaration Range (DR) and provides validation of the EO/IR DR against DAA alerting requirements.

Appendix D provides results of simulations and measurements to estimate signatures of different kinds of aircraft as guidance for EO/IR sensor system design against expected intruders. It also provides guidance for justification of EO/IR sensor system performance.

Appendix E provides results of simulations that assess the sensitivity of safety metrics to sensor system measurement errors and declaration range.

Appendix F describes a tracker that could be used in EO/IR sensor systems.

Appendix G provides a list of acronyms and abbreviations used in this document.

1.2 DAA System Overview

DAA systems are designed to provide UA the ability to remain well clear of and avoid collisions with other aircraft (referred to herein as "intruders"). Two types of surveillance equipment are identified for such a system: cooperative sensors such as Mode Select (Mode S) active surveillance and Automatic Dependent Surveillance-Broadcast (ADS-B), which rely on having compatible equipment in the intruder aircraft, and non-cooperative sensors, which detect intruders without any equipage assumptions. The EO/IR sensor system is a possible solution as the primary sensor for non-cooperative intruders. Paragraphs 1.2.1 and 1.2.2 give an outline of the UA elements and the CS elements of a DAA system.

The Federal Aviation Administration's (FAA's) UAS Operational Concept document includes assumptions, constraints, requirements, and high-level operational considerations for UAS, and is intended to provide the foundation for the DAA MOPS and DAA EO/IR sensor system MOPS.[1] However, the scope and functionality of the DAA MOPS and DAA EO/IR sensor system MOPS may require specific restrictions, operating limitations and/or supplemental operational controls or provisions to achieve an acceptable level of collision risk mitigation for use in the National Airspace System (NAS). Operating limitations for EO/IR sensor system equipment compliant with these MOPS are documented in Paragraph 1.2.4.

1.2.1 DAA System Description – Unmanned Aircraft

Figure 1-1 shows a simplified implementation of a DAA system onboard the aircraft, as depicted in RTCA Document 365A (DO-365A). The EO/IR sensor system interacts mainly with the UA DAA processor, which can be in the UA or in the CS. The EO/IR sensor system sends the EO/IR generated tracks to the DAA processor, which creates unified tracks that combine information from all sensors.

[1] Federal Aviation Administration (FAA) Integration of Civil Unmanned Aircraft Systems (UAS) into the National Airspace System (NAS), Second Edition, July 2018