

# **CHIEF OF NAVAL OPERATIONS**

**Functional Requirements Document**

**For**

**MODE SELECT**

**[FRD For Mode S]**

**Revision A**



**17 May 2006**

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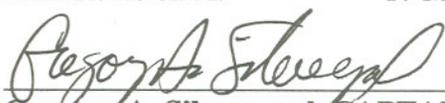
**FUNCTIONAL REQUIREMENTS DOCUMENT For  
MODE SELECT (Mode S)  
(FRD For Mode S)**

**PROGRAM TITLE:** COMMUNICATIONS/NAVIGATION/SURVEILLANCE/  
AIR TRAFFIC MANAGEMENT (CNS/ATM)

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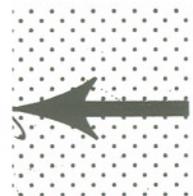
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## **CHANGE SUMMARY PAGE**

*This change summary page is provided to maintain a record of change to the last issue of the FRD. Upon receipt of a change or revision, the holder of the FRD should incorporate the change(s)/revision(s) into the original and make an appropriate entry on the Record of Change listing below:*

### **RECORD OF CHANGE**

<b>CHANGE NUMBER</b>	<b>DATE</b>	<b>CHANGE</b>	<b>ENTERED BY</b>
Initial Issue	14 July 2003	Document Baseline (under formal PMA209 Configuration Control)	Mr. Berk C. Hoover CNS/ATM IPTL
Revision A	17 May 2006	<p>Page iii, Added signature page.</p> <p>Page vii, Executive Summary – Improved readability and deleted superfluous information.</p> <p>Page 1, Para. 1.1 Deleted mention of 25 foot requirement as it is mentioned later in the document.</p> <p>Page 1, Para. 1.2 Corrected EUROCONTROL acronym, added requirement for transponders to meet AIMS 97-1000, and enhanced clarity.</p> <p>Pages 1-2, Para. 1.3 Split paragraph into paragraphs 1.3. and 1.4, revised wording and added sentence concerning latest European Mode S compliance mandate. Deleted information about NATO and Mode S.</p> <p>Page 2, Para. 1.3.1, Added paragraph addressing state transport aircraft requirements.</p> <p>Page 2, Para. 1.3.2, Added paragraph addressing state tactical aircraft requirements.</p> <p>Page 4, Para. 2.1 Updated the documents, deleted RTCA DO-181C, and modified the order of precedence.</p> <p>Page 4, Para. 2.2 Updated the DOD reference.</p> <p>Page 4, Para. 2.3 Modified the reference for NATO STANAG, Part I and NATMC Concept of Employment of Employment for Mode S</p> <p>Page 5, Para. 2.4 Updated EUROCONTROL references by adding Mode S Transition Arrangements for State Aircraft and deleted Mode S CONOPS.</p> <p>Page 5, Para. 2.5 Updated ICAO documents, adding ICAO Annex 10, Volume III and deleting ICAO documents 7030/4 and 9688-AN/952.</p> <p>Page 6, Para. 3.1, added requirements to support Surveillance Identifier Codes, requirements for transponder AIMS Certification and reworded other requirements.</p> <p>Page 6, Para. 3.1.1 Added paragraph outlining Navy requirements by platform type to integrate Elementary and Enhanced Surveillance.</p> <p>Page 7, renumbered former paragraph 3.1.1 as 3.1.2 and this impacted the following paragraphs as well. Revised Level 5 Definition. Added ICAO Reference.</p> <p>Page 7, Renumbered paragraph 3.1.1.1 as 3.1.2.1.</p> <p>Page 7, Renumbered Table 3.1.1.1-1 as Table 1 and added several undefined formats to the Not Required Column.</p> <p>Page 8, Revised the material originally in paragraph 3.1.1.2 and placed the new material in paragraphs 3.1.3, and 3.1.3.1 through 3.1.3.3.</p> <p>Page 8, Added paragraph 3.1.3.1 Elementary Surveillance.</p> <p>Page 8, Renumbered Table 3.1.1.2-1 as Table 2. and the title from “Elementary Surveillance Data Parameters” to “Elementary Surveillance Downlink Format”</p> <p>Page 8, Added Table 3 for Elementary Surveillance Data</p>	Mark Annee CNS/ATM Lead Surveillance Engineer

		<p>Parameters.</p> <p>Page 9, Revised enhanced surveillance material from paragraph 3.1.1.2 and created new paragraph 3.1.3.2.</p> <p>Page 9, Revised Table number from 3.1.1.2-2 to Table 4.</p> <p>Added alternative (TAS) for Track Angle Rate and Elementary Surveillance Functionality (BDS 1/0, etc.). Changed "Selected Altitude" to "Mode Control Panel/Flight Control Unit (MCP/FCU) Selected Altitude"</p> <p>Page 9, Created paragraph 3.1.3.3 to address BDS register update rates.</p> <p>Page 9, Revised Table number from 3.1.1.2-3 to Table 5, and revised times for minimum update rates for Common usage GICB capability report, track and turn report and heading and speed report and added note 3.</p> <p>Page 10, Renumbered para. 3.1.1.3 to 3.1.4. Mode S Squitter, revised wording and added "should" to support growth to Extended Squitter (ADS-B) and added subparagraphs a. and b. discussing Acquisition Squitter and Extended Squitter.</p> <p>Page10, Renumbered Para. 3.1.2 as 3.1.5, added Comm-A and Comm-U Processing requirements for TCAS-equipped aircraft and updated reference.</p> <p>Page10, Renumbered Para. 3.1.2.1 to Para. 3.1.5.1 and updated reference.</p> <p>Page 10 (14 July 03 Version), Deleted Para. 3.1.3, Military Specific Characteristics.</p> <p>Page 10 (14 July 03 Version) , Deleted paragraph 3.1.3.1, Receiver Sensitivity.</p> <p>Page 10, Renumbered Para. 3.1.3.2 as para. 3.1.6 and updated reference.</p> <p>Page 11, Renumbered Para. 3.1.3.3 as Paragraph 3.1.7, re-titled heading to "Transponder Controls", and revised the paragraph.</p> <p>Pages 11, Renumbered and renamed Table 3.1.3.3-1 as Table 6, and made the following changes:</p> <ol style="list-style-type: none"> <li>1. Added requirement to operate in diversity at all times except for maintenance purposes.</li> <li>2. Removed controls and indicators for most non-Mode S MK XII functions in Table 6.</li> <li>3. Deleted Acquisition Squitter ON/OFF capability.</li> <li>4. Revised Mode S Aircraft ID.</li> <li>5. Revised Mode S Max Airspeed to XXXX</li> <li>6. Revised Mode S Extended Squitter, adding "and may be implemented at a later date."</li> <li>7. Added ON/OFF for Mode S Enhanced Surveillance. In the OFF position, the transponder will operate in the Elementary Surveillance Mode only.</li> </ol> <p>Page 13 (14 July 03 Version), Deleted Table 3.1.3.3-2, Controls for Transponders with TCAS.</p> <p>Page 11, Renumbered paragraph 3.1.4 to 3.1.8 .</p> <p>Page 12, Added Para. 3.2, 3.2.1-3.2.3 concerning 24-bit Default and Selectable Addresses.</p> <p>Page 13, Appendix A Updated acronyms.</p>	
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## EXECUTIVE SUMMARY

This document establishes the minimum functional requirements for Navy, Marine Corps, and Coast Guard aircraft to conform to civil airspace mandates for Mode S surveillance. The Mode S Beacon System is a combined data link and Secondary Surveillance Radar (SSR) system that was standardized in 1985 by the International Civil Aviation Organization (ICAO) in the International Standards and Recommended Practices (SARPS) publication, ICAO Annex 10. Mode S is capable of supporting Air Traffic Control (ATC) automation in today's dense traffic environments with more capability than the current aging Air Traffic Control Radar Beacon System (ATCRBS) provides. It is also backward compatible with ATCRBS. Mode S transponder function is a Communication, Navigation, Surveillance / Air Traffic Management (CNS/ATM) Naval program requirement.

In the National Air Space, the Federal Aviation Administration (FAA) is transitioning to Mode S by installing new Mode S equipment at ATCRBS ground sites and has made both systems concurrent in operation. Mode S equipment is also gradually being installed into new production aircraft. Because both SSR ground beacon systems are in simultaneous operation, interrogated aircraft replies are dependent upon the type of transponder installed in the aircraft. The FAA is expected to migrate to Mode S operation in the future, as more aircraft become Mode S capable.

PMA209 is designated as the Navy Lead Program Office to coordinate Communication, Navigation, Surveillance / Air Traffic Management (CNS/ATM) efforts as chartered via Deputy Chief of Naval Operations for Air Warfare (N78) Letter (CNO Ser 7U660859 dated 14 October 1997). In accordance with this tasking, PMA209 has developed this Mode Select FRD for Naval, Marine Corps, and Coast Guard Aviation.

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## 1.0 INTRODUCTION

### 1.1 PURPOSE

This document establishes the minimum functional requirements for Navy, Marine Corps, and Coast Guard aircraft to conform to civil mandates for Mode S Elementary Surveillance (ELS) and Enhanced Surveillance (EHS). To meet these requirements, aircraft must be equipped with a Mode S Level 2 transponder with the capability for Comm-B data link communications (Standard Length Communications Protocol), antennas, an altitude source, an Air Data Link Processor (ADLP) or equivalent, and an appropriate control unit (Remote Control Unit or 1553 bus control). Aircraft that are designed, integrated, and tested to meet the functional requirements specified herein will be compliant with international standards for Mode S operation.

### 1.2 SCOPE

This Functional Requirements Document (FRD) specifically addresses the integration requirements for Navy, Marine Corps, and Coast Guard aircraft carrying Mode S transponders to comply with international civil Mode S standards in order to retain access to global airspace. Specific box-level transponder requirements are covered by AIMS 97-1000. The requirements stated in this document may or may not quote verbatim the European Organization for the Safety of Air Navigation (EUROCONTROL) references. The verbiage has been modified as necessary to facilitate Navy, Marine Corps, and Coast Guard needs and this document.

### 1.3 BACKGROUND

#### **Mode S Operation in European Air Space for State (military) aircraft**

The European Organization for the Safety of Air Navigation issued a directive on 22 August 2005 for the "Harmonisation of the Transition Arrangements for State aircraft". This directive details the process and procedures for the managing of the Mode S compliance status and the exemption granted to State aircraft. The directive for State aircraft allows exemptions for Mode S requirements in Europe to change from 2007 to 2009. The only exemptions allowed beyond the March 2009 deadline are for "aircraft that will be out of service by 31 December 2009 and aircraft used for flight testing, for delivery, or for transit into and out of maintenance bases".

**The final date for compliance for the carriage and operation of Mode S Elementary Surveillance (ELS) and Enhanced Surveillance (EHS) airborne equipment is 31 March 2009.**

The integration of Mode S Level 2 into Navy platforms is divided into two variations of functionality, Elementary Surveillance and Enhanced Surveillance. It is beneficial to air traffic control to incorporate EHS functionality to the extent practicable on all naval aircraft and to populate EHS data parameters to the extent permitted by existing aircraft sensors. The Mode S requirement is broken down into two types of aircraft.

### 1.3.1 STATE TRANSPORT AIRCRAFT

As stated by EUROCONTROL in their "Mode S Harmonisation of the Transition Arrangements for State Aircraft", Edition 1.1, "The carriage and operation of Mode S Enhanced Surveillance functionality applies to transport type State aircraft with a maximum take-off mass in excess of 5700kg or a maximum true cruising airspeed in excess of 250kts and a "full" Downlink of Aircraft Parameters capability, conducting Instrument Flying Rules (IFR) flights as General Air Traffic in Mode S Enhanced designated airspace for more than 30 hours per year per airframe."

The "full" set of Enhanced Surveillance Data Parameters are shown in Table 4 herein.

### 1.3.2 STATE TACTICAL AIRCRAFT

The carriage and operation of Mode S Elementary Surveillance functionality applies to Rotary-wing aircraft, training aircraft, unmanned air vehicles, and fighter aircraft that fly IFR and Visual Flight Rules flights in Mode S designated airspace.

## 1.4 EUROCONTROL Mode S Geographic Area and Airspace

The EUROCONTROL Concept of Operations (CONOPS) for Initial Implementation of Mode S Enhanced Surveillance (IIMSES) in Europe takes account of the geographic area defined as the Core Area. Figure 1-1 illustrates the core area of Mode S operations.

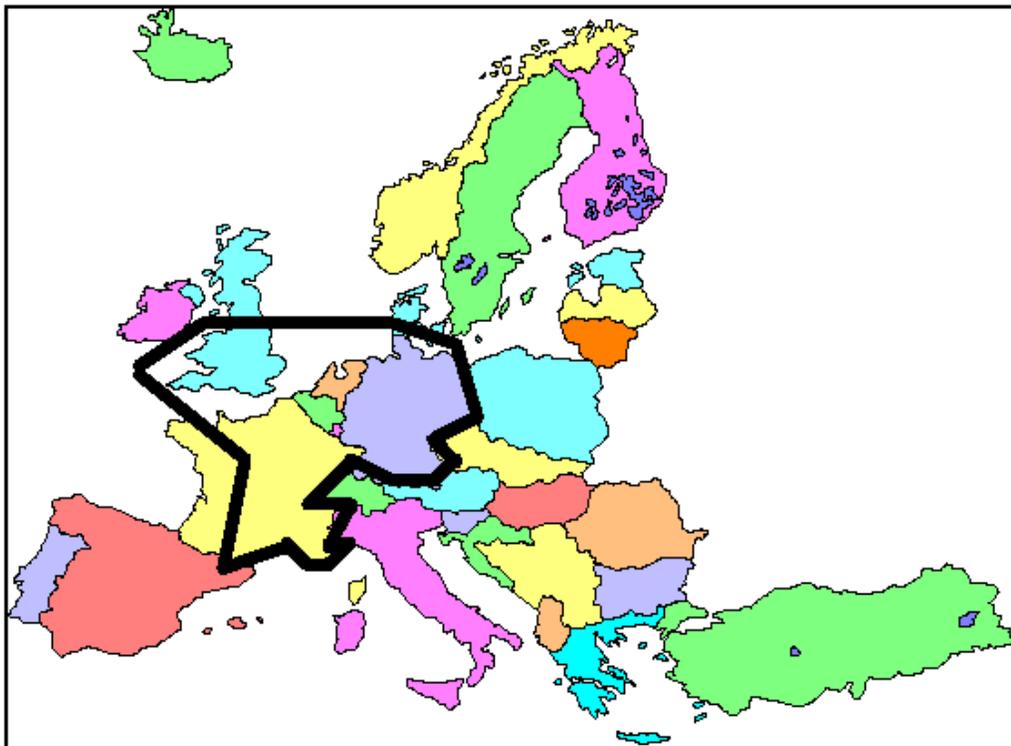
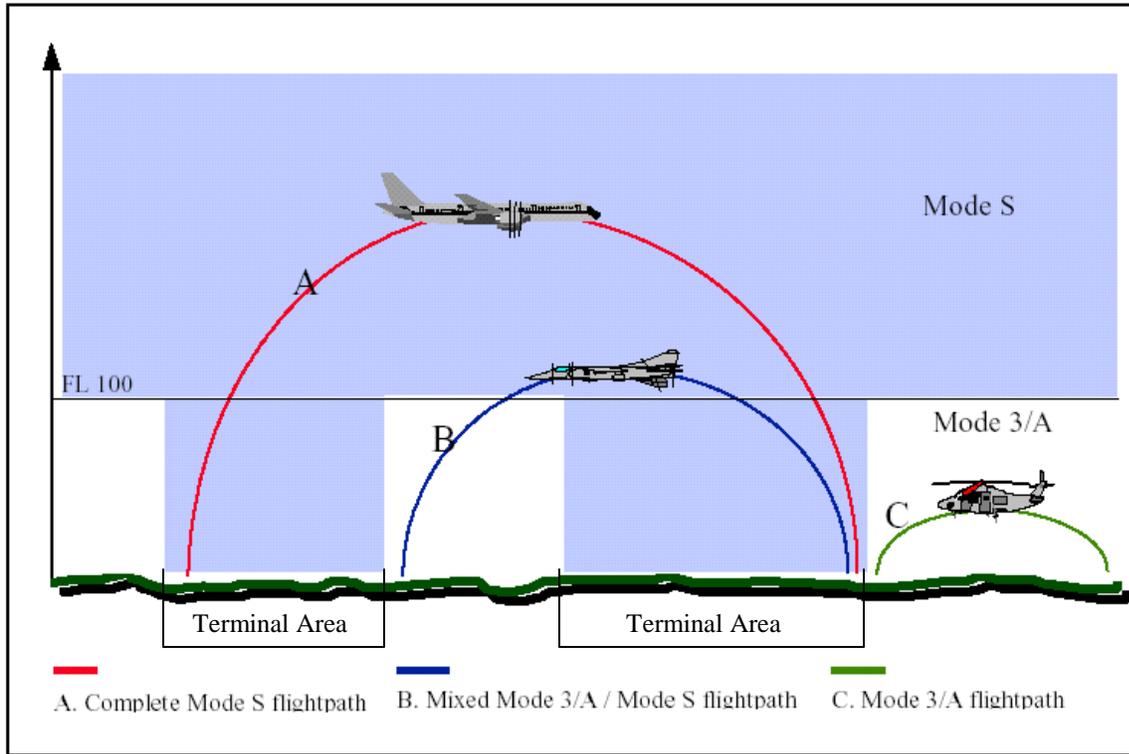


FIGURE 1-1. APPLICABLE AREA OF IIMSES

The CONOPS also takes into account the lateral aspects of the airspace applicable to the introduction of Enhanced Surveillance as defined in the IIMSES Strategy. This consists of at least duplicated Mode S radar coverage at and above a flight level of 10,000 feet (FL100). Figure 1-2 depicts an illustrative cross section of the IIMSES airspace.



**FIGURE 1-2. ILLUSTRATIVE CROSS SECTION OF MODE S AIRSPACE**

## **2.0 REFERENCE DOCUMENTS**

### **2.1 DOCUMENT ORDER OF PRECEDENCE FOR MILITARY MODE S REQUIREMENTS**

Requirements within this FRD are primarily based on airborne transponder Mode S functionality and interoperability guideline requirements. These requirements are identified in the DoD AIMS 97-1000, 18 March 1998, STANAG 4193 Parts I and IV, and ICAO Annex 10 Vol. III and IV. Air Traffic Control Radar Beacon System (ATCRBS), Identification Friend or Foe (IFF), Mark XII System (AIMS) equipment will incorporate Mode S capability to the extent required to perform the intended functions. Unless otherwise specified in this document, a military Mode S integration shall meet the applicable requirements of ICAO Annex 10 Vol. III and IV with exceptions that are detailed in STANAG 4193 Part IV. In case of a conflict, the order of precedence shall be this FRD, STANAG 4193 part IV, ICAO Annex 10, and then AIMS 97-1000.

### **2.2 DOD DOCUMENTS**

DoD AIMS 97-1000,  
18 March 1998

Performance/Design and Qualification  
Requirements Technical Standard for the  
ATCRBS/IFF/MARK XII Electronic Identification  
System and Military Mode S

### **2.3 NATO DOCUMENTS**

STANAG 4193, Part IV,  
12 April 1999

Technical Characteristics of IFF Mk XA and Mk  
XII Interrogators and Transponders-Technical  
Characteristics of Mode S in Military Interrogators  
and Transponders (NATO UNCLASSIFIED)

### **2.4 EUROCONTROL DOCUMENTS**

Mode S Harmonisation of the  
Transition Arrangements for  
State Aircraft Edition 1.1  
22 August 2005

Process and Procedures for the Managing of the  
Mode S Compliance Status and the Exemption  
Granted to State Aircraft

### **2.5 ICAO DOCUMENTS**

(a). ICAO Annex 10, to the  
Convention on Civil Aviation,  
Vol. III, Communication Systems  
1<sup>st</sup> edition, Amendment 78  
27 November 2003

Standards and Recommended Practices (SARPS)  
for Mode S (Digital Communications Systems)

(b). ICAO Annex 10, to the  
Convention on Civil Aviation,  
Vol. IV, Surveillance Radar and  
Collision Avoidance Systems  
3<sup>rd</sup> edition, Amendment 77  
28 November 2002

Standards and Recommended Practices (SARPS)  
for Mode S

## **2.6 RTCA DOCUMENTS**

(a). RTCA/DO-185A,  
16 December 1997

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

## **3.0 REQUIREMENTS**

### **3.1 GENERAL REQUIREMENTS**

The integration of a military Mode S transponder shall provide the operational capabilities of Mode S and shall not degrade Mark XII capabilities (Modes 1, 2, 3/A, C and 4) . The Mode S Level 2 transponder must comply with the provisions of ICAO Annex 10, Standards and Recommended Practices (SARPs), Amendment 77 to include supporting Surveillance Identifier codes. The Mode S transponder shall have an AIMS certification prior to platform Mode S certification.

#### **3.1.1 INTEGRATION OF MODE S IN AIRCRAFT**

All aircraft operating in Mode S designated airspace (with the exception of rotary-wing aircraft, training aircraft, and fighter aircraft) with a maximum take-off mass in excess of 5700kg or a maximum true cruising airspeed in excess of 250kts shall integrate Mode S Level 2 Enhanced Surveillance functionality. Mode S Enhanced Surveillance shall include full Downlink of Aircraft Parameters capability as specified in Table 4.

All aircraft operating in Mode S designated airspace not required to integrate Mode S Level 2 EHS functionality shall integrate Mode S Level 2 Elementary Surveillance. As an objective, these aircraft should also integrate Mode S Enhanced Surveillance parameters to the extent of the existing sensors and integrations available onboard the aircraft.

#### **3.1.2 AIRBORNE TRANSPONDER MODE S CAPABILITY AND FORMATS**

Mode S is an ATC system that can respond to selective interrogations and provide air-to-air and air-to-ground data link of Aircraft Identification (ID), state, and intent information. It is stipulated in ICAO SARPS Annex 10, that Mode S transponders shall conform to one of five Levels of capability:

- Level 1 This is the basic transponder. Level 1 permits surveillance based on Mode 3/A & C as well as Mode S. With a Mode S aircraft address, it comprises the minimum features for compatible operation with Mode S interrogators. It has no data link capability and will not be used by international air traffic control in EUROCONTROL. It is not permitted for use in the ICAO EUR.
- Level 2 Level 2 has the same capabilities as Level 1 but allows standard data link communications from ground-to-air and air-to-ground. It also includes automatic aircraft identification reporting. This is the minimum level permitted for international air traffic control in the ICAO EUR.
- Level 3 Level 3 has the same capabilities as Level 2, but allows extended data link communications from the ground to the aircraft.

- Level 4 Level 4 has the same capabilities as Level 3, but allows extended data link communications from the aircraft to the ground.
- Level 5 Level 5 has the same capabilities as Level 4, but allows for Comm-B and extended length data link communications with multiple interrogators without requiring the use of multi-site reservations. This level of transponder has the highest data link capability.

Mode S, Level 2 integration shall be the U.S. Navy minimum Mode S requirement. Levels 3, 4, and 5 are outside the scope of this FRD.

*Ref: ICAO Annex 10, paragraph 2.1.5.1, Vol. IV, amended.*

### 3.1.2.1 MODE S FORMATS

Mode S provides for twenty-five interrogation/reply format pairs, not all of which are currently defined. Each format pair consists of an interrogation Uplink Format (UF) and an associated transponder reply Downlink Format (DF). Each Mode S transponder shall be capable of operating with the formats listed as “Required” in Table 1.

**TABLE 1. MODE S FORMATS**

UF/DF	Message Format	Required	Future Growth	Not Required
0	Short (56-bit), Air to Air Surveillance (TCAS) <sub>1</sub>	X		
1 – 3	Undefined			X
4	Short (56-bit), Surveillance Altitude	X		
5	Short (56-bit), Surveillance Identity	X		
6 – 10	Undefined			X
11	Mode S Only All-Call	X		
12 – 15	Undefined			X
16	Long (112-bit), Air to Air Surveillance (TCAS) <sup>2</sup>	X		
17, 18	Extended Squitter (112-bit Standard ADS-B / DF Only)		X	
19	Extended Squitter (112-bit Military Format ADS-B / DF Only)		X	
20	Long (112-bit), Comm-A/B Altitude	X		
21	Long (112-bit), Comm-A/B Identity	X		
22, 23	Undefined			X
24	Long (112-bit), Comm-C/D, Extended Length Message			X

Notes:

<sup>1</sup> UF/DF 0 and 16 are used for TCAS operation. All transponder integrations are required to respond to UF 0 interrogations.

<sup>2</sup> Transponder integrated with TCAS processors shall respond to UF0 and UF16 interrogations.

### 3.1.3 ELEMENTARY AND ENHANCED SURVEILLANCE

#### 3.1.3.1 ELEMENTARY SURVEILLANCE

The Mode S Downlink Formats required to support Elementary Surveillance are provided in Table 2. The Mode S data parameters required to support Elementary Surveillance are provided in Table 3.

Military platforms are not required to process Mode S Comm-A uplink data unless the integration supports TCAS. If the installation supports TCAS, the Service Request shall be processed and the data off-loaded from the transponder.

*Ref: ICAO Annex 10, paragraph 3.1.2.6.11, Vol. IV, amended.*

*Note1: If a Mode S transponder is not connected to a data bus, then the transponder may accept the Comm-A data and store it in the transponder's queue and not process it.*

*Note2: In Any implementation, if the queue becomes overloaded it may be reset and the data discarded.*

**TABLE 2. ELEMENTARY SURVEILLANCE DOWNLINK FORMAT**

<b>Data Parameter</b>	<b>Downlink Format (DF)</b>
24-bit Address	11 (address only) All other DF (addresses overlaid with parity)
Mode 3/A Code	5, 21
Aircraft Identification	20, 21
Data Link Capability Report	20, 21
Active Resolution Advisories	16 (TCAS)
Altitude	4, 20
Flight Status	4, 5, 20, 21

**TABLE 3. ELEMENTARY SURVEILLANCE DATA PARAMETERS**

<b>Data Parameter</b>	<b>Comm-B Data Selector (BDS)</b>
Aircraft Identification	BDS 2,0
Data Link Capability Report	BDS 1,0
Common usage GICB capability report	BDS 1,7
Active Resolution Advisories.	BDS 3,0 (TCAS )

### 3.1.3.2 ENHANCED SURVEILLANCE

The Mode S data parameters required to support Enhanced Surveillance are provided in Table 4. Enhanced Surveillance provides improvements in air traffic capacity and safety by means of access to additional aircraft parameters.

**TABLE 4. ENHANCED SURVEILLANCE DATA PARAMETERS**

<b>Data Parameter</b>	<b>Comm-B Data Selector (BDS)</b>
Elementary Surveillance Functionality	BDS 1,0 /1,7 /2,0 / (3,0 TCAS)
Magnetic Heading	BDS 6,0
Indicated Airspeed	BDS 6,0
Mach No.	BDS 6,0
Vertical Rate	BDS 6,0
Roll Angle	BDS 5,0
Track Angle Rate or True Airspeed*	BDS 5,0
True Track Angle	BDS 5,0
Ground Speed	BDS 5,0
Mode Control Panel/Flight Control Unit (MCP/FCU) Selected Altitude (intentions)	BDS 4,0

*\*Note: If Track Angle Rate is not available, fill BDS 5,0 with True Airspeed .*

### 3.1.3.3 BDS REGISTER UPDATE RATES

Table 5 specifies the minimum update rate at which the Comm-B Data Selector (BDS) data in each register shall be reloaded with valid data. The value in BDS 2,0 register may be maintained by the transponder as long as power is applied to the unit.

**TABLE 5. BDS REGISTER UPDATE RATES**

<b>BDS Register</b>	<b>Assignment</b>	<b>Minimum Update Rate</b>
1,0	Data link capability report	≤ 4.0 s (Note 1)
1,7	Common usage GICB capability report	1.0 s
2,0	Aircraft identification	5.0 s
3,0	TCAS active resolution advisory	(Note 2)
4,0	Aircraft intention	1.0 s
5,0	Track and turn report	1.0 s
6,0	Heading and speed report	1.0 s

*Note 1: The data link capability report must be updated within one second of the data changing and at least every four seconds thereafter.*

*Note 2: BDS Register 3,0 updates are only required for TCAS-equipped aircraft as per ICAO Annex 10 Volume III.*

*Note 3: BDS Register 4,0; 5,0; and 6,0 updates are not required for Elementary Surveillance.*

*Ref: ICAO Annex 10 Volume III, Table 2.1 page 5-64, amended.*

### **3.1.4 MODE S SQUITTERS**

Mode S Level 2 transponders shall be capable of supporting Acquisition Squitter whenever Mode S is enabled. Additionally, Mode S Level 2 transponders should be capable of supporting Extended Squitter for future growth to Automatic Dependent Surveillance-Broadcast (ADS-B).

*Ref: ICAO Annex 10 Volume IV, paragraph 2.1.5.1.2, amended.*

a. Acquisition Squitter.

The Mode S transponder shall have the capability to generate acquisition squitters (DF 11).

b. Extended Squitter.

Extended squitter (DF 17-19) is an objective capability that may be integrated to provide ADS-B functionality.

### **3.1.5 MODE S TRANSPONDER TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS II) CAPABILITY**

Mode S transponders on aircraft equipped with a TCAS II system shall have data link Comm-U/V (UF/DF 16) capability. These transponders shall have the ability to interface with both an FAA TSO-C119B and RTCA/DO-185A capable TCAS II unit. Mode S systems on aircraft that are equipped with TCAS shall be capable of processing all Comm-A and Comm-U message contents designated for the TCAS processor.

*Ref: (1) DoD AIMS 97-1000, Para.3.14.5 (2) ICAO Annex 10 Part IV, Para. 3.1.2.8*

#### **3.1.5.1 MODE S TRANSPONDER / TCAS INTERFACE**

An RTCA/DO-185A compatible transponder shall announce its capability to the on-board TCAS via a dedicated ARINC 429 interface. Likewise, an RTCA/DO-185A compatible TCAS announces its capability to the on-board transponder via a separate, dedicated ARINC 429 interface. The capability of the transponder/TCAS system is then limited to the capability of either the transponder or TCAS unit having least capability.

*Ref: ICAO Annex 10 Part IV, Para. 3.1.2.8*

### **3.1.6 EMERGENCY**

An emergency feature shall be provided for Modes 1, 2, 3/A, and S replies. When emergency is selected, the transponder shall reply in all four modes 1, 2, 3/A, and S irrespective of the settings of those modes. When Mode S is enabled, selecting emergency shall cause the Flight Status field of DF=4, 5, 20, and 21 Mode S replies to indicate a permanent alert condition.

*Ref: DOD AIMS 97-1000, Para. 3.2.9 and 3.14.8.4*

### 3.1.7 TRANSPONDER CONTROLS

The Mode S controls shall be implemented as detailed in Table 6.

**TABLE 6. CONTROLS FOR MODE S TRANSPONDERS**

Parameter	Value	Notes
Mode S Enable	ON/OFF	This enables or disables replies to Mode S interrogations. Depending on the Mode S level of integration into the aircraft will determine the Mode S reply level capability. <i>Ref. AIMS 97-1000, para. 3.14.7.2</i>
Mode S Address	8-digit octal or 6-digit hex	This allows for entering of a Mode S 24-bit address. It can be entered as either an 8-digit octal value or a 6-digit hexadecimal value. The 8-digit octal value is recommended. If desired the capability to enter the address in either format may be provided.
Mode S Aircraft ID	XXXXXXXX	This allows for entering of the aircraft ID associated with the <u>flight plan</u> . The value entered contains up to 8 alphanumeric characters with the unused trailing characters to be space characters. (see note below)
Mode S Max. Airspeed	XXXX	This allows for the entering of an aircraft's max cruising airspeed. The value is typically set once. <i>Ref. ICAO Annex 10 Volume IV Para. 3.1.2.8.2.2.</i>
Mode S Extended Squitter	ON/OFF	This is a growth option and may be implemented at a future date. The control turns extended squitter on or off. This squitter provides additional surveillance information about the aircraft.
Mode S Enhanced Surveillance	ON/OFF	This control turns on or off the transmission of Enhanced Surveillance parameters. When off the transponder will operate in Elementary Surveillance mode only. <i>Ref. AIMS 97-1000, para. 3.14.7.2</i>
MIC/Ident	ON/MIC/OFF	This momentary switch enables the Ident function. If integrated to the microphone keyline the Ident function may also be enabled when the microphone is keyed.
Antenna Select	TOP/BOT/DIV	This selects the antenna mode – Top (UP), Bottom (LO), or Diversity (DIV). Platforms are required to operate in Diversity at all times with selection available for maintenance purposes.

*Note: Mode S Aircraft ID entry must be entered in accordance with DoD FLIP General Planning, chapter 4. This reference limits the entry of flight ID to 7 alphanumeric characters.*

### **3.1.8 ALTITUDE CODE**

The altitude code is reported as a 13-bit data field in DF 4 and 20 replies. The desired altitude report shall be in 25 ft. increments. However in cases where that capability is not available, reporting in 100 ft. increments will be acceptable.

### **3.2 NAVY MODE S 24-BIT ADDRESS**

All Navy aircraft that are Mode S equipped shall have “stored” into the aircraft a Mode S 24-bit address assigned to that aircraft and shall have the capability to enter a Selectable Mode S 24-bit Address.

*Note: “Stored” is defined as follows:*

*The address may be resident in a piece of hardware, a non-volatile software code, a fixed cable wiring technique, or some other design.*

#### **3.2.1 MODE S 24-BIT DEFAULT ADDRESS**

U.S. Navy aircraft shall have a single, unique 24-bit Mode S address that is called the 24-bit Default Address. This 24-bit Default Address is cross-referenced to an aircraft Bureau Number (BUNO). This Default Address stays with the aircraft until aircraft end of life.

#### **3.2.2 MODE S 24-BIT SELECTABLE ADDRESS**

U.S. Navy aircraft shall have the capability to change (overwrite) the Mode S 24-bit Default Address to a Mode S 24-bit Selectable Address. When changing the Mode S 24-bit address Mode S should be disabled and preferably the aircraft should be on the ground.

#### **3.2.3 POWER INTERRUPTIONS AND 24-BIT ADDRESS**

Power interruptions (no power condition) to the transponder shall not negatively affect aircraft’s storage of the 24-bit Default Address. Current policy for transponder integrations is as follows:

##### **3.2.3.1 POWER INTERRUPTION – AIRBORNE.**

When the aircraft is airborne and the aircraft transponder is operating with a 24-bit Selectable Address, and power fails, the transponder shall “restart” using either the 24-bit Selectable Address or revert to the 24-bit Default Address.

##### **3.2.3.2 POWER INTERRUPTION – WEIGHT ON WHEELS.**

After mission completion and all power is removed from the aircraft, and the transponder system is restarted, the 24-bit Default Address shall be used unless there is a mission planning over-ride or operator action to input a 24-bit Selectable Address.

## APPENDIX A. ACRONYMS AND ABBREVIATIONS

ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance- Broadcast
AIMS	Air Traffic Control Radar Beacon System, Identification Friend or Foe, Mark XII System
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
ATM	Air Traffic Management
CNS/ATM	Communication, Navigation, Surveillance / Air Traffic Management
CNO	Chief of Naval Operations
CONOPS	Concept of Operations
DF	Downlink Formats
DoD	Department of Defense
EUR	European
EUROCAE	European Organization for Civil Aviation Electronics
EUROCONTROL	European Organization for the Safety of Air Navigation
FAA	Federal Aviation Administration
FL	Flight Level in hundreds of feet (FL100=10,000 feet)
FRD	Functional Requirements Document
GICB	Ground Initiated Comm-B
ICAO	International Civil Aviation Organization
ID	Identification
IFR	Instrument Flight Rules
IIMSES	Initial Implementation of Mode S Enhanced Surveillance
MCP/FCU	Mode Control Panel/Flight Control Unit
Mode S	Mode Select
MTL	Minimum Triggering Level
NATO	North Atlantic Treaty Organization
RA	Resolution Advisory
RTCA	RTCA, Inc., Formerly Radio Technical Commission for Aeronautics
SARPS	International Standards and Recommended Practices
SSR	Secondary Surveillance Radar
STANAG	(NATO) Standardization Agreement
TA	Traffic Advisory
TCAS	Traffic Alert and Collision Avoidance System
UF	Uplink Formats
VFR	Visual Flight Rules