



ICAO

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**THE FOURTH MEETING OF MODE S DOWNLINKED  
AIRCRAFT PARAMETERS WORKING GROUP  
(MODE S DAPs WG/4)**

Video Teleconference, 29 – 31 March 2021

**Agenda Item 7:** Review Guidance Material of implementation of Mode S DAPs

**SUGGESTION OF INCLUDING ADS-B DAPs IN DAPs IGD**

(Presented by China)

**SUMMARY**

This paper suggests to include ADS-B DAPs in DAPs IGD and describes the aircraft parameters in ADS-B DAPs, the reasons for the suggestion, and other related issues.

**1. INTRODUCTION**

1.1 At present, dozens of BDS registers in the Mode S transponder have been defined. The V2 DAPs IGD has included the related technologies and applications of the Mode S SSR DAPs registers, which include BDS1,0, BDS1,7, BDS2,0, BDS3,0, BDS4,0, BDS5,0, BDS6,0.

1.2 In recent years, the application of ADS-B in the APAC region has reached a certain scale. It is suggested that technologies and applications related to ADS-B DAPs should also be included in the DAPs IGD.

1.3 Recommended modifications include ADS-B DAPs description, ADS-B DAPs application, and DAPs extraction strategy optimization under the hybrid operation of Mode S radar and ADS-B, etc.

**2. DISCUSSION**

Aircraft parameters in ADS-B DAPs

2.1 ADS-B DAPs refers to aircraft parameters transmitted to the ground system via the ADS-B device, which include:

- Aircraft identification, aircraft emitter category;
- GNSS information: latitude, longitude, height, altitude, velocity, vertical rate, accuracy and integrity of GNSS information;
- Flight vector status: ground speed, indicated airspeed, true airspeed, true track angle, magnetic heading;
- Pilot inputted information: selected altitude, selected heading, barometric pressure setting;
- Emergency/priority status, TCAS/ACAS RA broadcast;

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- Capability class and operational mode status.

## 2.2

Registers associated with ADS-B DAPs are as follows:

<b>BDS Code</b>	<b>Register Description</b>
0,5	Extended Squitter Airborne Position
0,6	Extended Squitter Surface Position
0,7	Extended squitter status
0,8	Extended Squitter Identification and Category
0,9	Extended Squitter Airborne Velocity
0,A	Extended Squitter Event-Driven Information
6,1	Extended Squitter Aircraft Status
6,2	Target State and Status Information
6,5	Extended Squitter Aircraft Operational Status

*Note: The aircraft parameters associated with which register could refer to Appendix 1 ADS-B Downlink Aircraft Parameters and DAPs\_WG3\_IP08\_Aircraft Parameters Availability in Mode S DAPs and ADS-B ADD.*

Reasons for including ADS-B DAPs in DAPs IGD

## 2.3

Mode S SSR and ADS-B DAPs are complementary. More DAPs and higher data availability can be achieved by using both data at the same time.

- GNSS information and selected heading are specific data of ADS-B DAPs;
- Roll angle, track angle rate, Mach number and inertial vertical velocity are specific data of Mode S SSR DAPs;
- More emergency types in ADS-B DAPs than identified by radar secondary codes.

<b>Radar Emergency Status</b>	<b>Emergency Status in ADS-B DAPs</b>
-	No emergency
7700/Emergency	General emergency
-	Lifeguard/Medical
-	Minimum fuel
7600/Lost Communication	No communications
7500/Aircraft Hijacking	Unlawful interference
-	Downed aircraft

## 2.4

The same aircraft parameter obtained by ADS-B and Mode S SSR may be difference.

## 2.4.1

Even the aircraft transponder is capable of sending airspeed and magnetic heading through both ADS-B and Mode S SSR, the validity of airspeed and magnetic heading in ADS-B DAPs and Mode S SSR DAPs has the significant difference due to the ADS-B transmission mechanism (note 1). According to the previous statistics, for the same batch of aircrafts, less than 1% of them had transmitted airspeed and magnetic heading via ADS-B, while the validity of airspeed and magnetic heading in Mode S SSR DAPs is more than 99%.

## 2.4.2

For the same aircraft parameter, ADS-B DAPs and Mode S DAPs may be derived from different BDS register. For example, the RA information of Mode S SSR DAPs is derived from BDS 3,0, while the RA information of ADS-B DAPs is derived from BDS 6,1.

*Note 1: Airspeed and magnetic heading from ADS-B DAPs are available only if the aircraft's velocity over ground is unknown (see DOC-9871 C.2.3.5.2)*

2.5 From the perspective of the application, the ATM automation system will comprehensively use the aircraft parameters in Mode S SSR and ADS-B DAPs. It is more meaningful to consider the application of these two data at the same time.

Application example of ADS-B DAPs

2.6 According to monitor the applications of ADS-B in China, the proportion of aircraft equipped with ADS-B V2 transponders rose from 27% in early 2018 to nearly 50 % by the end of 2020. The availability of ADS-B DAPs is getting higher and higher. At present, the application of ADS-B DAPs has been studied. The existing applications or researches are as follows:

- Optimize route deviation warning using selected heading;
- Detect GPS interference using GNSS information;
- Optimize the performance of track prediction by using GNSS information and selected heading, especially the performance of turning;
- Evaluate radar positioning accuracy by using GNSS position;
- RVSM height-keeping performance monitoring by using GNSS height.

Optimization of DAPs extraction strategy under hybrid operation

2.7 Resources of 1090MHz band are limited. If a region uses Mode S radar and ADS-B at the same time, it should be used as a whole.

2.8 The interrogation resources of Mode S radar are limited. Usually the Mode S radar could acquire three extra BDS registers in one antenna scan period. If aircraft parameter in ADS-B DAPs is enough for use, the Mode S radar could optimize the DAPs extraction strategy. The interrogation resources saved can be used for other information acquisition. For example, an application only uses the selected altitude in BDS 4,0. If the selected altitude in ADS-B DAPs can meet the requirements of this application, the radar could reduce or stop the interrogation of BDS 4,0.

2.9 The availability of DAPs depends on the capacity of airborne equipment. It is recommended to continuously monitor the capacity of airborne equipment to transmit DAPs through Mode S SSR and ADS-B, and optimize the DAPs extraction strategy.

**3. ACTION BY THE MEETING**

3.1 Note the proposals contained in this paper and attachments;

3.2 Discuss any related issues as appropriate.

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## Appendix 1. ADS-B Downlink Aircraft Parameters

Note:

- Red: Version 0 or 1 parameters which are different from version 2.
- The content and format of register 0A<sub>16</sub> depend on the event triggered.

### Register 05<sub>16</sub>, Airborne Position Message

Bits	Version 0	Version 1	Version 2
	Airborne Position Message	Airborne Position Message	Airborne Position Message
6~7	Surveillance Status	Surveillance Status	Surveillance Status
8	Single Antenna Flag	Single Antenna Flag	NIC Supplement-B
9~20	Altitude	Altitude	Altitude
21	Time (T)	Time (T)	Time (T)
22	CPR Format (F)	CPR Format (F)	CPR Format (F)
23~39	CPR Encoded Latitude	CPR Encoded Latitude	CPR Encoded Latitude
40~56	CPR Encoded Longitude	CPR Encoded Longitude	CPR Encoded Longitude

### Register 06<sub>16</sub>, Surface Position Message

Bits	Version 0	Version 1	Version 2
	Surface Position Message	Surface Position Message	Surface Position Message
6~12	Movement	Movement	Movement
13	Ground Track Status	Heading/Ground Track Status	Heading/Ground Track Status
14~20	Ground Track	Heading/Ground Track	Heading/Ground Track
21	Time (T)	Time (T)	Time (T)
22	CPR Format (F)	CPR Format (F)	CPR Format (F)
23~39	CPR Encoded Latitude	CPR Encoded Latitude	CPR Encoded Latitude
40~56	CPR Encoded Longitude	CPR Encoded Longitude	CPR Encoded Longitude

### Register 07<sub>16</sub>, Extended squitter status

Bits	Version 0	Version 1	Version 2
	Extended squitter status	Extended squitter status	Extended squitter status
1~2	Transmission rate Subfield (TRS)	Transmission rate Subfield (TRS)	Transmission rate Subfield (TRS)
3	Altitude Type (Baro/GNSS)	Altitude Type (Baro/GNSS)	Altitude Type (Baro/GNSS)

### Register 08<sub>16</sub>, Aircraft Identification and Category Message

Bits	Version 0	Version 1	Version 2
	Aircraft Identification and Category Message	Aircraft Identification and Category Message	Aircraft Identification and Category Message
6~8	Aircraft Category	ADS-B Emitter Category	ADS-B Emitter Category
9~56	Identification Characters #1-#8	Identification Characters #1-#8	Identification Characters #1-#8

### Register 09<sub>16</sub>, Airborne Velocity Message - Velocity over Ground with Subtype=1/2

Bits	Version 0	Version 1	Version 2
	Airborne Velocity Message - Velocity over Ground	Airborne Velocity Message - Velocity over Ground	Airborne Velocity Message - Velocity over Ground
6~8	Subtype=1/2	Subtype=1/2	Subtype = 1/2
9	Intent Change Flag	Intent Change Flag	Intent Change Flag

11~13	NUCr	NACv	NACv
14~24	E/W Velocity	E/W Velocity	E/W Velocity
25~35	N/S Velocity	N/S Velocity	N/S Velocity
36	Vertical Rate Source	Vertical Rate Source	Vertical Rate Source
37~46	Vertical Rate	Vertical Rate	Vertical Rate
49~56	Difference from Barometric Altitude	Difference from Barometric Altitude	Difference from Barometric Altitude

**Register 09<sub>16</sub>, Airborne Velocity Message - Velocity over Ground with Subtype=3/4**

Bits	Version 0	Version 1	Version 2
	Airborne Velocity Message - Airspeed	Airborne Velocity Message - Airspeed	Airborne Velocity Message - Airspeed
6~8	Subtype=3/4	Subtype=3/4	Subtype =3/4
9	Intent Change Flag	Intent Change Flag	Intent Change Flag
11~13	NUCr	NACv	NACv
14~24	Heading	Heading	Heading
25	Airspeed Type	Airspeed Type	Airspeed Type
26~35	Airspeed	Airspeed	Airspeed
36	Vertical Rate Source	Vertical Rate Source	Vertical Rate Source
37~46	Vertical Rate	Vertical Rate	Vertical Rate
49~56	Difference from Barometric Altitude	Difference from Barometric Altitude	Difference from Barometric Altitude

**Register 61<sub>16</sub>, Extended squitter Emergency/priority status (and Mode A Code)**

Bits	Version 0	Version 1	Version 2
	Extended squitter Emergency/priority status	Aircraft Status Message - Emergency/priority status	Aircraft Status Message – Emergency/Priority Status and Mode A Code
6~8	Subtype=1	Subtype=1	Subtype = 1
9~11	Emergency State	Emergency State	Emergency State
12~24			Mode A Code

**Register 61<sub>16</sub>, Aircraft Status Message - ACAS RA Broadcast**

Bits	Version 0	Version 1	Version 2
		Aircraft status Message - Extended squitter ACAS RA Broadcast	Aircraft Status Message - ACAS RA Broadcast
6~8		Subtype =2	Subtype = 2
9~22		Active Resolution Advisories	Active Resolution Advisories
23~26		RACs Record	RACs Record
27		RA Terminated	RA Terminated
28		Multiple Threat Encounter	Multiple Threat Encounter
29~30		Threat Type Indicator	Threat Type Indicator
31~56			Threat Identity Data

**Register 62<sub>16</sub>, Target State and Status Information with Subtype=0**

Bits	Version 0	Version 1	Version 2
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		<b>Target State and Status Information</b>	
6~7		Subtype = 0	
8~9		Vertical Data Available/Source Indicator	
10		Target Altitude Type	
12~13		Target Altitude Capability	
14~15		Vertical Mode Indicator	
16~25		Target Altitude	
26~27		Horizontal Data Available/Source Indicator	
28~36		Target Heading/Track Angle	
37		Target Heading/Track Indicator	
38~39		Horizontal Mode Indicator	
40~43		NAC <sub>P</sub>	
44		NIC <sub>BARO</sub>	
45~46		Source Integrity Level (SIL)	
52~53		Capability/Mode Codes	
54~56		Emergency/Priority Status	

**Register 62<sub>16</sub>, Target State and Status Information with Subtype=1**

Bits	Version 0	Version 1	Version 2
			<b>Target State and Status Message</b>
6~7			Subtype = 1
8			SIL Supplement
9			Selected Altitude Type
10~20			<u>MCP/FCU Selected Altitude or</u> FMS Selected Altitude
21~29			Barometric Pressure Setting
30~39			Selected Heading
40~43			Navigation Accuracy Category Position (NAC <sub>P</sub> )
44			Navigation Integrity Category Baro (NIC <sub>BARO</sub> )
45~46			Source Integrity Level (SIL)
47			Status of MCP/FCU Mode Bits
48			Autopilot Engaged
49			VNAV Mode Engaged
50			Altitude Hold Mode
52			Approach Mode
53			TCAS Operational
54			LNAV Mode Engaged

**Register 65<sub>16</sub>, Extended Squitter Aircraft Operational Status with Subtype=0**

Bits	Version 0	Version 1	Version 2
	Extended Squitter Aircraft Operational Status	Extended Squitter Aircraft Operational Status	Aircraft Operational Status Message - While Airborne
6~8	Subtype = 0	Subtype = 0	Subtype = 0
9~12	En-Route Operational Capabilities(CC-4)	Airborne Capability Class Codes -Not-ACAS -CDTI -ARV -TS -TC	Airborne Capability Class Codes -TCAS/ACAS Operational -1090 ES IN -ARV -TS -TC -UAT IN
13~16	Terminal Area Operational Capabilities(CC-3)		
17~20	Approach/Landing Operational Capabilities(CC-2)		
21~24	Surface Operational Capabilities(CC-1)		
25~28	En-Route Operational Capability Status(OM-4)	Airborne Operational Mode Codes -ACAS RA Active -IDENT switch active -Receiving ATC services	Airborne Operational Mode Codes -TCAS/ACAS RA Active -IDENT Switch Active -Single Antenna Flag -SDA
29~32	Terminal Area Operational Capability Status(OM-3)		
33~36	Approach/Landing Operational Capability Status(OM-2)		
37~40	Surface Operational Capability Status(OM-1)		
41~43		Version Number = 1	Version Number = 2
44		NIC Supplement	NIC Supplement-A
45~48		NAC <sub>P</sub>	NAC <sub>P</sub>
49~50		Barometric Altitude Quality (BAQ)	GVA
51~52		Source Integrity Level	Source Integrity Level
53		NIC <sub>Baro</sub>	NIC <sub>Baro</sub>
54			Horizontal Reference Direction (HRD)
55			SIL Supplement

**Register 65<sub>16</sub>, Extended Squitter Aircraft Operational Status with Subtype=1**

Bits	Version 0	Version 1	Version 2
		Extended Squitter Aircraft Operational Status	Aircraft Operational Status Message - On the Surface
6~8		Subtype = 1	Subtype = 1
9~12		Surface Capability Class (CC) Codes -CDTI -POA -B2 Low	Surface Capability Class (CC) Codes -1090 ES IN -B2 Low -UAT IN -NAC <sub>v</sub> -NIC Supplement-C
13~16			
17~20			
21~24		Length/Width Codes	Length/Width Codes
25~28		Surface Operational Mode (OM) Codes -ACAS RA Active -IDENT switch active -Receiving ATC services	Surface Operational Mode (OM) Codes -TCAS/ACAS RA Active -IDENT Switch Active -Single Antenna Flag -SDA -GPS Antenna Offset
29~32			
33~36			
37~40			
41~43		Version Number = 1	Version Number = 2

44		<b>NIC Supplement</b>	NIC Supplement-A
45~48		NAC <sub>P</sub>	NAC <sub>P</sub>
49~50			
51~52		Source Integrity Level	Source Integrity Level
53		TRK/HDG	TRK/HDG
54		Horizontal Reference Direction (HRD)	Horizontal Reference Direction (HRD)
55			SIL Supplement

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