

International Civil Aviation Organization



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**THE THIRD MEETING OF MODE S DOWNLINKED
AIRCRAFT PARAMETERS WORKING GROUP
(MODE S DAPs WG/3)**

Web-conference, 12 – 15 May 2020

Agenda Item 4: Mode S monitoring and analysis

AIRCRAFT PARAMETERS AVAILABILITY IN MODE S DAPS AND ADS-B ADD

(Presented by China)

SUMMARY

This paper presents aircraft downlink parameters in Mode S DAPs and ADS-B Aircraft Derived Data(ADD). And a study was conducted in Guangzhou China to confirm which parameters were available at present.

1. INTRODUCTION

1.1 In the past year, there were 74 Mode S radars and 308 ADS-B ground stations in China put into operation. A study about ADS-B ADD and Mode S DAPs was conducted to confirm which parameters were available.

1.2 The Mode S radars with EHS capability in China are configured to extract BDS4,0, BDS5,0 and BDS6,0.

1.3 ADD is a surveillance application in which avionics data are transmitted from the aircraft to the ground and possibly other aircraft. ADS-B ADD in this paper refers to the BDS data broadcasted by ADS-B transponder. Data needs to be interrogated is not considered.

1.4 Some parameters in ADS-B ADD, such as selected altitude, barometric pressure setting, MCP/FCU mode and selected heading, were not defined in ADS-B version 0. These parameters' capable percentage would increase a lot when transponders are all upgraded to latest version.

2. CORRESPONDING BDS REGISTERS

2.1 The BDS registers corresponding to the aircraft downlink parameters are shown in table-1:

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Table-1 Parameters Registers

Parameter		Mode S DAPs	ADS-B ADD
Barometric Altitude		Mode C	0,5
Longitude and Latitude			0,5/0,6
Ground Speed		5,0	0,6/0,9
True Track Angle		5,0	0,6
			0,9(see 2.1.1)
Aircraft Identification(Flight Ident.)		2,0	0,8
Vertical Rate	Barometric Altitude Rate	6,0	0,9
	Inertial Vertical Velocity	6,0	
	GNSS Vertical Rate		0,9
GNSS Height(HAE) (see 2.1.2)			0,5+0,9
			0,5
True Airspeed		5,0	0,9(see 2.1.3)
Indicated Airspeed		6,0	
Selected Altitude	MCP/FCU Selected Altitude	4,0	6,2(Version 2)
	FMS selected altitude		
Target Altitude		4,0(see 2.1.4)	6,2 (Version 1 and above)
MCP/FCU mode(see 2.3)		4,0	6,2
Barometric Pressure Setting(BPS)		4,0	6,2
Roll Angle		5,0	
Track Angle Rate		5,0	
Magnetic Heading		6,0	0,9(see 2.1.3)
Mach No.		6,0	
Selected Heading/Target Heading			6,2 (Version 1 and above)

2.1.1 True track angle could be calculated by the ground speed in BDS 0,9.

2.1.2 HAE could be downlinked in BDS0,5, or be calculated by barometric altitude in BDS 0,5 and GNSS altitude difference from barometric altitude in BDS 0,9.

2.1.3 Airspeed and magnetic heading in ADS-B ADD is transmitted only if ground speed is unavailable.

2.1.4 Target altitude in Mode S DAPs could be calculated by target altitude source bits and selected altitude in BDS4,0.

2.2 The parameters received from Mode S radar are updated in a different rate than ads-b ground station.

2.2.1 Mode S DAPs' update rate is determined by the radar's extraction strategy, may up to once per radar scan.

2.2.2 ADS-B ADD's update rate is shown in Table-2

Table-2 ADS-B Message Update Interval

BDS	Assignment	Maximum Update Interval
0,5	Extended Squitter Airborne Position	0.2s
0,6	Extended Squitter Surface Position	0.2s
0,8	Extended Squitter Identification and Category	15s
0,9	Extended Squitter Airborne Velocity	1.3s
6,2	Target State And Status Information	0.5s
6,5	Aircraft Operational Status	1.7s (Version 0) 2.5s (Version 1 and 2)

2.3 There is more information about MCP/FCU mode in ADS-B ADD. It would be helpful to use the intent data. MCP/FCU mode in ADS-B ADD is available after ADS-B version 2.

Table-3 MCP/FCU Mode in Mode S DAPs and ADS-B ADD

Mode	MCP/FCU Mode in Mode S DAPs	MCP/FCU Mode in ADS-B ADD
Autopilot	x	✓
VNAV Mode	✓	✓
Altitude Hold Mode	✓	✓
Approach Mode	✓	✓
TCAS/ACAS Operational	x	✓
LNAV Mode	x	✓

3. AVAILABLE PARAMETERS

3.1 1763 aircrafts' Mode S DAPs and ADS-B ADD were collected in Guangzhou China. Mode S DAPs were collected from Asterix Cat 048 from a Mode S radar. ADS-B ADD were collected from DF message from an ADS-B ground station. Aircrafts detected by both radar and ADS-B were considered. And a statistic was made to identify which parameters were available.

3.2 Barometric altitude and flight Ident. from Mode S radar, longitude, latitude and flight Ident. from ADS-B were highly available based on practical. So they were not counted.

3.3 BDS 0,6 is transmitted only when the aircraft is on the ground. So it's not available in most cases. It's not considered in this statistic.

3.4 Capable percentage in Mode S DAPs is shown in Table-4.

Table-4 Capable Percentage in Mode S DAPs

Parameter	Capable Aircrafts	Total Aircrafts	Capable Percentage
Barometric Altitude	Not Counted		
Longitude and Latitude	No Information		
Ground Speed	1760	1763	99.83%
True Track Angle	1760	1763	99.83%
Aircraft Identification(Flight Ident.)	Not Counted		
Vertical Rate	1758	1763	99.72%
GNSS Height(HAE)	No Information		

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True Airspeed	1760	1763	99.83%
Indicated Airspeed	1758	1763	99.72%
Selected Altitude	1757	1763	99.66%
Target Altitude(see 3.4.1)	31	1763	1.76%
MCP/FCU mode	68	1763	3.86%
Barometric Pressure Setting	1757	1763	99.66%
Roll Angle	1760	1763	99.83%
Track Angle Rate	1760	1763	99.83%
Magnetic Heading	1758	1763	99.72%
Mach No.	1758	1763	99.72%
Selected Heading/Target Heading	No Information		

3.5 Capable percentage in ADS-B ADD is shown in Table-5:

Table-5 Capable Percentage in ADS-B ADD

Parameter	Capable Aircrafts	Total Aircrafts	Capable Percentage
Barometric Altitude	1644	1763	93.25%
Longitude and Latitude	Not Counted		
Ground Speed	1651	1763	93.65%
True Track Angle	1651	1763	93.65%
Aircraft Identification(Flight Ident.)	Not Counted		
Vertical Rate	1656	1763	93.93%
GNSS Height(HAE)	1637	1763	92.85%
True Airspeed	5	1763	0.28%
Indicated Airspeed	3	1763	0.17%
Selected Altitude	313	1763	17.75%
Target Altitude(see 3.5.1)	55	1763	3.12%
MCP/FCU mode	70	1763	3.97%
Barometric Pressure Setting(BPS)	313	1763	17.75%
Roll Angle	No Information		
Track Angle Rate			
Magnetic Heading	7	1763	0.40%
Mach No.	No Information		
Selected Heading/Target Heading	283	1763	16.05%

3.5.1 Target altitude were defined in ADS-B version 1. Only aircrafts with version 1 transponder were transmitted this parameter in this statistic.

4. CONCLUSION

4.1 Capable percentage of parameters in Mode S DAPs and ADS-B ADD were summary as table-6:

Table-6 Mode S DAPs and ADS-B ADD Availability

Parameter	Capable Percentage in Mode S DAPs	Capable Percentage in ADS-B ADD
Barometric Altitude	Not Counted	93.25%
Longitude and Latitude	No information	Not Counted
Ground Speed	99.83%	93.65%
True Track Angle	99.83%	93.65%
Aircraft Identification(Flight Ident.)	Not Counted	
Vertical Rate	99.72%	93.93%
GNSS Height(HAE)	No information	92.85%
True Airspeed	99.83%	0.28%
Indicated Airspeed	99.72%	0.17%
Selected Altitude	99.66%	17.75%
Target Altitude	1.76%	3.12%
MCP/FCU mode	3.86%	3.97%
Barometric Pressure Setting	99.66%	17.75%
Roll Angle	99.83%	No information
Track Angle Rate	99.83%	No information
Magnetic Heading	99.72%	0.40%
Mach No.	99.72%	No information
Selected Heading/Target Heading	No information	16.05%

5. ACTION BY THE MEETING

5.1 The Meeting is invited to

- a) note the above information; and
- b) discuss any relevant matters as appropriate; and
- c) further research is needed.
