RTCA Special Committee 209

ATCRBS / Mode S Transponder

Meeting #4

Honeywell, Olathe, Kansas
18 – 19 October 2006

EUROCAE WG49N8	**Working Paper WG49N8-TBD**
Action (A5/05 Continued)	**AGENDA Item TBD**
EASA, Cologne, Germany__October 4-6, 2006	

Updated Issues
With
BDS 4,0 Data Loading
(In support of Action Item 3-1 regarding MSSS)

Prepared by R.H. "Bob" Saffell, Rockwell Collins, Inc.
(Presented by R.H. "Bob" Saffell)

SUMMARY

The intent of this document is to address remaining issues regarding the setting of various Mode Bits in BDS 4,0 in regards to Target Altitude.

This document draws heavily on information previously provided in ICAO ASP/WG-B, WP B10-30, 12 April 2006, Agenda Item 5.1.1, "Example for the Loading of Data in Register 40_{16}".

This document also draws heavily on the current definition of BDS 4,0 provided in ICAO Doc. 9871, Table A-2-64, which is included in the material identified in the previous paragraph. This document also addresses issues with ICAO Doc. 9871 Appendix C, section C.2.1.4.3 inclusive in regards to Register Number 40_{16}.

The topic has been discussed multiple times over recent years, yet the issues are not fully resolved. This document provides additional commentary in the hopes of closing the issue and is intended for presentation at Eurocae WG-49 Meeting 8 to be held in Cologne, Germany, October 5-6, 2006. Likewise, this document is intended for presentation at RTCA SC-209 Meeting #4, to be held in Olathe, Kansas, October 18-19, 2006.

Attachments:

(1). ICAO Doc 9871 Draft Edition Rev 2-2006, Table A-2-64. BDS 4,0---Selected Vertical Intention

(2). ICAO ASP/WG-B, WP B10-30, 12 April 2006, Agenda Item 5.1.1, "Example for the Loading of Data in Register 40_{16}"

1. Introduction

Early definitions of BDS Register 40_{16} provided prior to and in ICAO Doc 9688-AN/952, "Manual of Mode S Specific Services", First Edition – 1997, identified the "MB" field as having Selected Altitude, Selected Altitude Rate, Selected Magnetic Course/Heading, and Selected Airspeed/Mach aircraft parameters. Acquire, Capture, and Hold mode bits were also allocated for each of the aircraft parameters.

During the development of Eurocae ED-86 (now obsolete due to replacement by ARINC-718A) and ARINC-718A, it was pointed out that at least 5 different control words would be required from the Flight Control and Autopilot Systems in order set the appropriate mode bits. Furthermore, it was emphasized that virtually no two aircraft configurations provided the same or equivalent control words that could be used to establish the mode bits.

Since the developments discussed above, multiple changes have been made to BDS 4,0. Specifically, the parameters were changed to being MCP/FCU Selected Altitude, FMS Selected Altitude, and Barometric Pressure Setting as indicated in Attachment (1). Also, mode bits were changed to those shown in Attachment (1), and include setting of Target Altitude Source bits. The setting of these bits has created confusion since inception and continues to do so today. As an aside, it should be noted that at one time the FMS Selected Altitude field of BDS 4,0 was actually defined as Target Altitude and it was inferred that the Target Altitude Source bits identified what type of altitude was being used to fill the Target Altitude parameter field. Needless to say, this led to further confusion as various entities indicated that the Target Altitude Source bits should indicate which altitude source is controlling or being used to control the aircraft vertical profile. Material indicating Target Altitude Source selection was provided as early as ICAO SCRSP/WGB, WP/B/1-5, Agenda Item 5.6, April 2001, Rio de Janeiro.

Today, BDS 4,0 is defined as shown in Attachment (1) and guidance material for the setting of the mode bits is provided in ICAO Doc. 9871 Appendix C, section C.2.1.4.3. Such guidance material allows that the logic used to determine Target Altitude Source selection is highly dependent upon the airframe configuration and that appropriate data may not be available to establish the logic.

Admitting that excessive confusion exists in the industry in regards to BDS 4,0, Attachment (2) makes a valiant attempt at clarifying the situation by presenting a possible example of how to determine the Target Altitude Source Selection. This document reviews Attachment (2) and demonstrates that a simpler solution is available based on the assumption that the intent is to show which altitude source is being used to control or guide the aircraft vertical profile.

2. Review of Attachment 1:

Attachment (1) includes an "Attachment 1" which provides a general example for the loading of data in register 40_{16}. As such, "Attachment 1" provides a figure which demonstrates an example flight profile and correlates the figure with a table indicating the appropriate setting of the Target Altitude Source bits in register 40_{16}. Table 1, below, replicates the table from "Attachment 1" and adds a final row in which to declare Case Numbers for each stage of flight column.

Table 1: Replication of "Attachment 1" Table

Register 40 Hex Content	**MCP/FCU Selected Altitude**		**100**	**300**	**300**	**300**	**300**	**300**	**300**
	FMS Selected Altitude		**250**	**250**	**250**	**350**	**350**	**350**	**350**
	MCP/FCU Mode Bits	**Provided**	1	1	1	1	1	1	1
		VNAV	0	1	1	1	0	0	0
		Alt Hold	1	0	0	0	1	0	1
		Approach	0	0	0	0	0	0	0
	Target Altitude (Unknown, Altitude, FCU/MCP, FMS)		FCU / MCP	FMS	FMS	FCU / MCP	FCU / MCP	Altitude	Altitude
		CASE #	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Table 2, below, then provides discussion and commentary regarding each of the Flight Profile phases on a Case Number basis. Primary points of emphasis are indicated in bold red font in the table.

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Table 2: Case Analysis of Table 1 Flight Profile

Table 2: Case Analysis of Table 1 Flight Profile		
CASE #	**DESCRIPTION**	**PROBLEM / COMMENT**
1	MCP/FCU Selected Altitude is set at 100, Aircraft Reaches 100, then Autopilot/Flight Director is engaged and is holding the selected altitude.	At this point, the Autopilot/Flight Director is holding the commanded altitude of 100 since that is the last command received from the MCP/FCU. Effectively, the Autopilot being engaged should set the MCP/FCU Mode Bits Provided (e.g., Bit 48) to "1". Once the Autopilot is Holding the MCP/FCU Selected Altitude, then the Altitude Hold bit (e.g., Bit 50) should be set to "1". At this point the FCU/MCP Selected Altitude and the Aircraft Altitude should be equivalent but the FCU/MCP Selected Altitude provides the command, so it is in control and Bits 55, 56 should be set to "10" to indicate Target Altitude = FCU/MCP. As such, there is no conflict with Case #1 and **no changes are necessary to the table given above**.
2	A newly cleared Flight Level of 300 has been entered into the system via the MCP/FCU Selected Altitude ***AND*** VNAV has been engaged with the FMS. However, the FMS has calculated an intermediate Flight Level of 250 and is flying the aircraft to that Flight Level.	In this case, the FMS is clearly in control of the Target Altitude as it is flying the aircraft to an intermediate Flight Level of 250 while enroute to the MCP/FCU Commanded Selected Altitude. Effectively, if VNAV Mode (e.g., Bit 49 is set to "1" (active)), ***AND*** the Autopilot is engaged (e.g., Bit 48 is set to "1" (active)), then the FMS is in control and Bits 55, 56 should be set to "11" to indicate Target Altitude = FMS As such, there is no conflict with Case #2 and **no changes are necessary to the table given above**.
3	The FMS has captured and is maintaining the intermediate Flight Level of 250 which was determined in Case #2.	In this case, the FMS is clearly in control of the Target Altitude as it is keeping the aircraft at the intermediate Flight Level of 250 while remaining VNAV enabled and Autopilot coupled. As such, there is no conflict with Case #3 and **no changes are necessary to the table given above**.
4	The FMS has now decided to continue to the MCP/FCU Selected Altitude of 300 and determines a desired Flight Level of 350. Note that VNAV is still engaged and active.	During the duration of Case #4, the FMS is actively VNAV coupled and is attempting to fly the aircraft to Flight Level 350. As such, the FMS is clearly in control of the Target Altitude and NOT the FCU/MCP as indicated in the table above. Otherwise, there is conflict with Case #2 and #3 which are clearly under control of the FMS in VNAV mode. Accordingly, **the table below changes the Target Altitude control to "FMS" (e.g., Bits 55,56 = 11) from "FCU/MCP"**. As Register 40_{16} provides MCP/FCU Selected Altitude and FMS Selected Altitude, and the System is VNAV Coupled, observers of BDS 4,0 should be able to determine that the FMS is flying the aircraft to FL 350 enroute to FL 300 which is the MCP/FCU Selected Altitude.

Table 2: Case Analysis of Table 1 Flight Profile (continued)		
CASE #	**DESCRIPTION**	**PROBLEM / COMMENT**
5	At the beginning of Case #5, the FMS has flown the aircraft to the MCP/FCU commanded altitude of 300 while in the VNAV mode. Therefore, the VNAV mode is now disengaged and the Autopilot/Flight Director should continue to hold the altitude at FL 300.	At this point, the Autopilot/Flight Director is holding the commanded altitude of 300 since that is the last command received from the MCP/FCU. The Autopilot is engaged in the VNAV mode and should set the MCP/FCU Mode Bits Provided (e.g., Bit 48) to "1". Once the Autopilot is Holding the MCP/FCU Selected Altitude, then the Altitude Hold bit (e.g., Bit 50) should be set to "1". At this point the FCU/MCP Selected Altitude and the Aircraft Altitude should be equivalent but the FCU/MCP Selected Altitude provides the command, so it is in control and Bits 55, 56 should be set to "10" to indicate Target Altitude = FCU/MCP. As such, there is no conflict with Case #5 and **no changes are necessary to the table given above**.
6	During the duration of Case #6, the flight crew had disengaged the autopilot and is flying the aircraft manually.	Since the pilot has disengaged the autopilot completely, **NO** Mode Bits are really available ***AND / OR*** should not be applicable to selecting the Target Altitude since the Pilot is in control of the aircraft. Effectively, the Autopilot being disengaged should set the MCP/FCU Mode Bits Provided (e.g., Bit 48) to "0". Therefore, in order to remove the Mode bit conflict, **the table below changes the MCP/FCU Mode Bits Provided state from "1" to "0", since the Autopilot is disengaged.** At this point, Aircraft Altitude is the only possible choice for Target Altitude and Bits 55,56 should be set to "01".
7	During the duration of Case #7, the flight crew has selected Altitude Hold via the autopilot.	In this case, the Autopilot is clearly in control since it has been engaged by selecting Altitude Hold. Most Autopilots will set the Selected Altitude equal to the Hold Altitude at this point. Therefore, MCP/FCU Selected Altitude and Aircraft Altitude are effectively equivalent and the Target Altitude should be set to FCU/MCP. If the Target Altitude is set to Aircraft Altitude as in the table above, then there is conflict between Case #7 and Case #1 and 5. Therfore, in order to remove the possibility of conflict, the table below changes **Target Altitude control to "FCU/MCP" (e.g., Bits 55,56 = 10) from "Aircraft Altitude"**.

Table 3, below Updates Table 1 with the changes made in the discussions of Table 2. Changes are shown in Bold Red font and shaded in yellow.

<u>Table 3</u>: Updated Replication of "Attachment 1" Table

Register 40 Hex Content	**MCP/FCU Selected Altitude**		**100**	**300**	**300**	**300**	**300**	**300**	**300**
	FMS Selected Altitude		**250**	**250**	**250**	**350**	**350**	**350**	**350**
	MCP/FCU Mode Bits	**Provided**	1	1	1	1	1	**0**	1
		VNAV	0	1	1	1	0	0	0
		Alt Hold	1	0	0	0	1	0	1
		Approach	0	0	0	0	0	0	0
	Target Altitude (Unknown, Altitude, FCU/MCP, FMS)		FCU / MCP	FMS	FMS	**FMS**	FCU / MCP	Altitude	**FCU / MCP**
		CASE #	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Using the terminology of "FCU/MCP Selected Altitude" as being in charge of the Target Altitude as done in BDS 4,0 (e.g., Register 4016) is really a poor terminology. As indicated in the following Figure 1, there are only three Major inputs of control to the aircraft vertical flight profile:

a. Crew Manual Control into the Autopilot or Flight Control System,

b. Autopilot Using command inputs from the MCP/FCU and inputs from the Air Data System, and

c. Autopilot Coupled to the FMS in the VNAV mode

Effectively, control is provided by either Manual, Autopilot, or FMS

Typically, it is the Autopilot that is really in control when responding to the MCP/FCU Selected Altitude or to the Altitude Hold function. In order to resolve the conflict in Case #7 where Table 1 calls out Target Altitude of "Altitude" and Table 3 calls out "FCU/MCP", it would be more accurate to call out "Autopilot" or "A/P" in Table 3 as opposed to "FCU/MCP". The Altitude Hold Bit (e.g., Bit 50) in Register 40_{16} then determines whether the MCP/FCU Selected Altitude is in control or if the Aircraft Altitude is actually in control. Remember that when in Altitude Hold, the MCP/FCU Selected Altitude and the Aircraft Altitude are the same as far as most Autopilot systems are concerned. Accordingly, Table 4, reflects this change. Changes are shown in Bold Red font and shaded in yellow.

<u>Table 4</u>: Updated Replication of "Attachment 1" Table

Register 40 Hex Content	**MCP/FCU Selected Altitude**		**100**	**300**	**300**	**300**	**300**	**300**	**300**
	FMS Selected Altitude		**250**	**250**	**250**	**350**	**350**	**350**	**350**
	MCP/FCU Mode Bits	**Provided**	1	1	1	1	1	**0**	1
		VNAV	0	1	1	1	0	0	0
		Alt Hold	1	0	0	0	1	0	1
		Approach	0	0	0	0	0	0	0
	Target Altitude (Unknown, Altitude, **Autopilot**, FMS)		**Auto Pilot**	FMS	FMS	**FMS**	**Auto Pilot**	Altitude	**Auto Pilot**
		CASE #	**1**	**2**	**3**	**4**	**5**	**6**	**7**

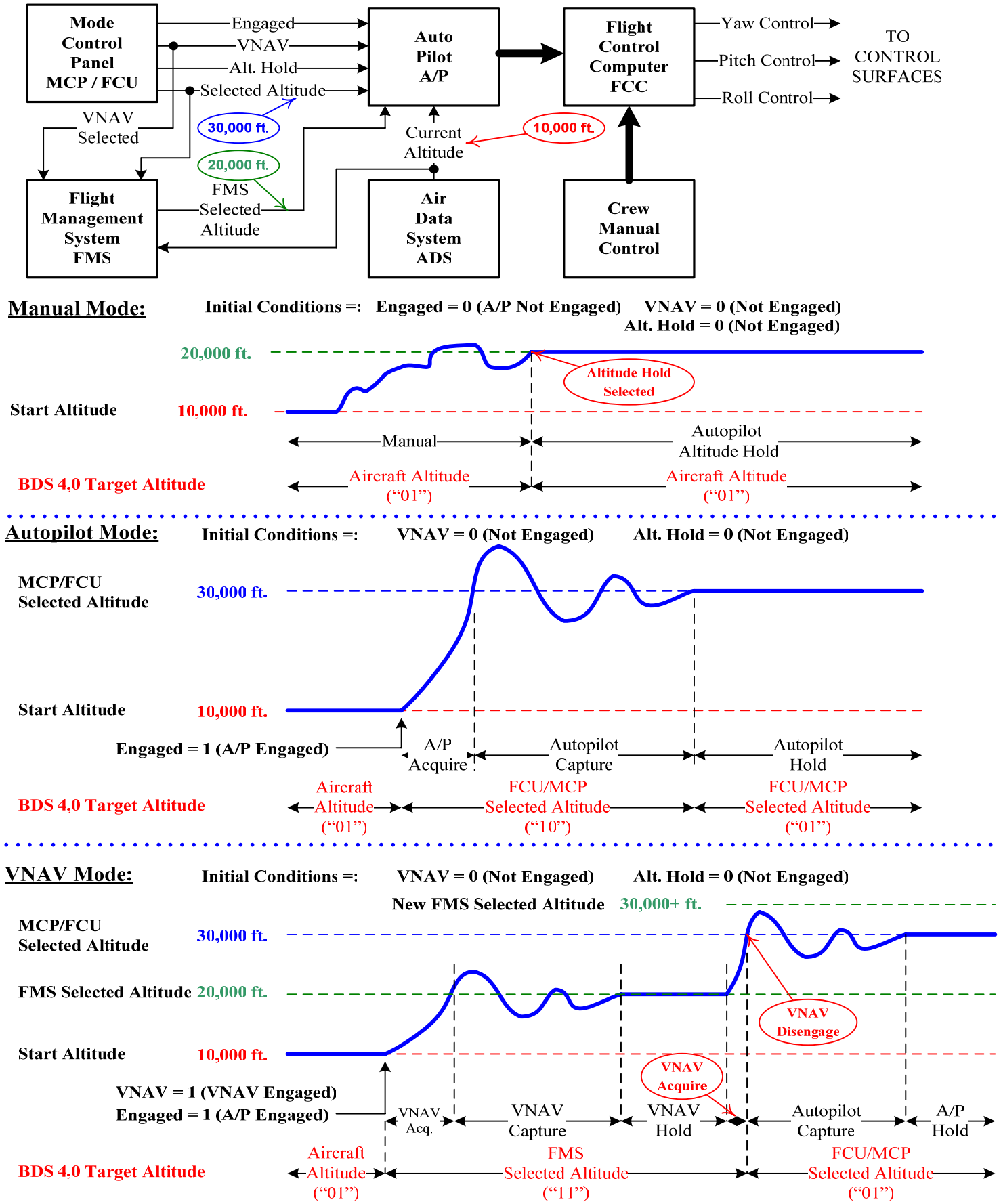

Figure 1: **Simplified Basic Flight Modes**

Table 5, below, summarizes the simplified settings of the Target Altitude Source Bits demonstrated in the discussions above.

Table 5: Required Settings of Target Altitude Source Bits

Required Settings of Target Altitude Source Bits								
Bit Name	**Status of MCP/FCU Mode Bits [See Note 2]**	**VNAV Mode**	**Alt. Hold Mode**	**Approach Mode [See Note 3]**	**Status of Target Alt. Source Bits**	**Target Alt. SRC MSB**	**Target Alt. SRC LSB**	**System Providing Target Altitude Control (or comment as needed)**
Bit #	**48**	**49**	**50**	**51**	**54**	**55**	**56**	
ITEM #								
1	**0**	**X**	**X**	**X**	**0**	**0**	**0**	**Unknown**
2	**0**	**X**	**X**	**X**	**1**	**0**	**1**	**Aircraft Altitude (e.g., Air Data System) (alternatively, "00" for Unknown)**
3	**X**	**X**	**X**	**X**	**0**	**0**	**0**	**Unknown**
4	**1**	**0**	**0**	**X**	**1**	**1**	**0**	**Autopilot**
5	**1**	**0**	**1**	**X**	**1**	**1**	**0**	**Autopilot**
6	**1**	**1**	**0**	**X**	**1**	**1**	**1**	**FMS Selected Altitude**
7	**1**	**1**	**1**	**X**	**1**	**1**	**1**	**FMS Selected Altitude [See Note 4]**

Notes:

1. **"X" in this table indicates a "Don't Care" condition.**
2. **Bit 48 should be a reflection of the Autopilot Engage Status where "0"=Autopilot Not Engaged and "1" = Autopilot Engaged**
3. **Setting of the Approach Mode has no impact on the setting of the Target Altitude Source Bits. Therefore, all Approach Mode states are marked as "X".**
4. **The setting of the Altitude Hold Mode Bit when in VNAV Mode has no impact as the FMS is still in control during the VNAV mode**

3. Summary / Conclusion:

The preceding discussions have narrowed the possible sources of Target Altitude to either Manual, Autopilot, or VNAV (e.g., FMS). Table 5 provides a simplified methodology for setting the Target Altitude Source Bits in BDS 4,0 (e.g., Register 40_{16}) based on Autopilot being engaged/disengaged, Altitude Hold engaged/disengaged, and VNAV engaged/disengaged. This methodology is considerably simpler than the logic proposed in ICAO Doc. 9871 Appendix C, section C.2.1.4.3., yet clearly depicts what system is controlling the vertical flight profile of the aircraft.

Should the various applicable working groups agree to this solution, then it is recommended that ICAO Doc 9871 Draft Edition Rev 2-2006, Table A-2-64 be changed to read as shown on the following pages where changes are shown in bold Red fond.

As a final closing comment by the author after having pursued this exercise, it is apparent that if the Ground System has all information provided in BDS 4,0 bits 1 through 26 and also has bits 48 through 50, then it already has all the information necessary to establish the settings of bits 55 and 56. This fact lends support to the point that the aircraft installation and transponder (in particular) should not be overly burdened with establishing the setting of bits 55 and 56. Making the setting of bits 55 and 56 overly complicated for the installation and transponder (in particular) creates a situation where it is virtually impossible to test all of the possible permutations on the aircraft installation; thereby complicating the certification process.

Table A-2-64. BDS 4,0 — Selected vertical intention

MB FIELD

1	STATUS
2	MSB = 32 768 ft
3	
4	
5	MCP/FCU SELECTED ALTITUDE
6	
7	
8	
9	Range [0, 65 520] ft
10	
11	
12	
13	LSB = 16 ft Resolution
14	STATUS
15	MSB = 32 768 ft
16	
17	
18	FMS SELECTED ALTITUDE
19	
20	
21	
22	Range [0, 65 520] ft
23	
24	
25	
26	LSB = 16 ft Resolution
27	STATUS
28	MSB = 204.8 mb
29	
30	
31	
32	BAROMETRIC PRESSURE SETTING
33	MINUS 800 mb
34	
35	
36	Range [0, 410] mb
37	
38	
39	LSB = 0.1 mb Resolution
40	
41	
42	
43	
44	RESERVED
45	
46	
47	
48	STATUS OF MCP/FCU MODE BITS
49	VNAV MODE
50	ALT HOLD MODE
51	APPROACH MODE
52	RESERVED
53	
54	STATUS OF TARGET ALT SOURCE BITS
55	TARGET ALT SOURCE
56	TARGET ALT SOURCE

PURPOSE: To provide ready access to information about the pilot's current vertical intentions, in order to improve the effectiveness of conflict probes and to provide additional tactical information to controllers.

1) Target altitude shall be the short-term intent value, at which the aircraft will level off (or has leveled off) at the end of the current maneuver. The data source that the aircraft is currently using to determine the target altitude shall be indicated in the altitude source bits (54 to 56) as detailed below.

   Note.— This information which represents the real "aircraft intent", when available, represented by the altitude control panel selected altitude, the flight management system selected altitude, or the current aircraft altitude according to the aircraft's ***autopilot (e.g., flight controller)*** *mode of flight (the intent may not be available at all when the pilot is flying the aircraft).*

2) The data entered into bits 1 to 13 shall be derived from the mode control panel/flight control unit or equivalent equipment. Alerting devices may be used to provide data if it is not available from "control" equipment. The associated mode bits for this field (48 to 51) shall be as detailed below

3) The data entered into bits 14 to 26 shall be derived from the flight management system or equivalent equipment managing the vertical profile of the aircraft

4) The current barometric pressure setting shall be calculated from the value contained in the field (bits 28 to 39) plus 800 mb.

   When the barometric pressure setting is less than 800 mb or greater than 1 209 5 mb, the status bit for this field (bit 27) shall be set to indicate invalid data

5) Bits 48 to 56 shall indicate the status of the **systems that are providing the** values provided in bits 1 to 26 as follows:

   Bit 48 shall indicate whether the mode bits (49, 50 and 51) are actively being populated: **(Effectively, this translates into whether or not the Autopilot or Flight Control System is Engaged or Not Engaged in regards to controlling the Flight Profile of the Aircraft)**

   0 = No mode information provided
   (e.g., Autopilot or Flight Control System is Not Engaged)
   1= Mode information deliberately provided
   (e.g., Autopilot or Flight Control System is Engaged)

   Bits 49, 50 and 51:

   0 = Not active **(e.g., Not Engaged)**
   1 = Active **(e.g., Engaged)**

   Bit 54 shall indicate whether the target altitude source bits (55 and 56) are actively being populated.

   0 = No source information provided
   1 = Source information deliberately provided

   Bits 55 and 56, shall indicate target altitude source:

   00 = Unknown
   01 = Aircraft altitude
   10 = Autopilot (e.g., FCU / MCP Selected Altitude or Altitude Hold)
   11 = FMS selected altitude **(e.g., Autopilot Coupled and in VNAV Mode)**

   When Autopilot Mode, VNAV Mode, and Altitude Mode information is available, then bits 54, 55, and 56 shall be set in accordance with Table A provided below this table. Otherwise, when appropriate Mode information is not available, then bits 54, 55, and 56 shall be set to ZERO.

Table A: Required Settings of Target Altitude Source Bits								
Bit Name	Status of MCP/FCU Mode Bits [See Note 2]	VNAV Mode	Alt. Hold Mode	Approach Mode [See Note 3]	Status of Target Alt. Source Bits	Target Alt. SRC MSB	Target Alt. SRC LSB	System Providing Target Altitude Control (or comment as needed)
Bit #	48	49	50	51	54	55	56	
ITEM #								
1	0	X	X	X	0	0	0	Unknown
2	0	X	X	X	1	0	1	Aircraft Altitude (e.g., Air Data System) (alternatively, "00" for Unknown)
3	X	X	X	X	0	0	0	Unknown
4	1	0	0	X	1	1	0	Autopilot
5	1	0	1	X	1	1	0	Autopilot
6	1	1	0	X	1	1	1	FMS Selected Altitude
7	1	1	1	X	1	1	1	FMS Selected Altitude [See Note 4]

Notes:

1. "X" in this table indicates a "Don't Care" condition.
2. Bit 48 should be a reflection of the Autopilot Engage Status where "0"=Autopilot Not Engaged and "1" = Autopilot Engaged
3. Setting of the Approach Mode has no impact on the setting of the Target Altitude Source Bits. Therefore, all Approach Mode states are marked as "X".
4. The setting of the Altitude Hold Mode Bit when in VNAV Mode has no impact as the FMS is still in control during the VNAV mode

END of DOCUMENT: (Attachments Follow)

Attachment (1)
Table A-2-64. BDS 4,0 — Selected vertical intention

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26	LSB = 16 ft Resolution
27	STATUS
28	MSB = 204.8 mb
29	
30	
31	
32	BAROMETRIC PRESSURE SETTING
33	MINUS 800 mb
34	
35	
36	Range [0, 410] mb
37	
38	
39	LSB = 0.1 mb Resolution
40	
41	
42	
43	
44	RESERVED
45	
46	
47	
48	STATUS OF MCP/FCU MODE BITS
49	VNAV MODE
50	ALT HOLD MODE
51	APPROACH MODE
52	RESERVED
53	
54	STATUS OF TARGET ALT SOURCE BITS
55	TARGET ALT SOURCE
56	TARGET ALT SOURCE

PURPOSE: To provide ready access to information about the pilot's current vertical intentions, in order to improve the effectiveness of conflict probes and to provide additional tactical information to controllers.

1) Target altitude shall be the short-term intent value, at which the aircraft will level off (or has leveled off) at the end of the current maneuver. The data source that the aircraft is currently using to determine the target altitude shall be indicated in the altitude source bits (54 to 56) as detailed below.

   Note.— This information which represents the real "aircraft intent", when available, represented by the altitude control panel selected altitude, the flight management system selected altitude, or the current aircraft altitude according to the aircraft's mode of flight (the intent may not be available at all when the pilot is flying the aircraft).

2) The data entered into bits 1 to 13 shall be derived from the mode control panel/flight control unit or equivalent equipment. Alerting devices may be used to provide data if it is not available from "control" equipment. The associated mode bits for this field (48 to 51) shall be as detailed below

3) The data entered into bits 14 to 26 shall be derived from the flight management system or equivalent equipment managing the vertical profile of the aircraft

4) The current barometric pressure setting shall be calculated from the value contained in the field (bits 28 to 39) plus 800 mb.

   When the barometric pressure setting is less than 800 mb or greater than 1 209 5 mb, the status bit for this field (bit 27) shall be set to indicate invalid data

5) Bits 48 to 56 shall indicate the status of the values provided in bits 1 to 26 as follows:

   Bit 48 shall indicate whether the mode bits (49, 50 and 51) are actively being populated:

   0 = No mode information provided
   1= Mode information deliberately provided

   Bits 49, 50 and 51:

   0 = Not active
   1 = Active

   Bit 54 shall indicate whether the target altitude source bits (55 and 56) are actively being populated.

   0 = No source information provided
   1 = Source information deliberately provided

   Bits 55 and 56, shall indicate target altitude source:

   00 = Unknown
   01 = Aircraft altitude
   10 = FCU/MCP selected altitude
   11 = FMS selected altitude

Attachment (2)

International Civil Aviation Organization

WORKING PAPER

ASP/WG-B
WP B10-30
12 April 2006
Agenda Item 5.1.1

AERONAUTICAL SURVEILLANCE PANEL (ASP)

10TH MEETING OF WG-B

Montreal, 8th to 12th of May 2006

EXAMPLE FOR THE LOADING OF DATA IN REGISTER 40_{16}

(Prepared by Eric Potier and Mikaël Ponnau, presented by Eric Potier)

Summary

A lot of questions have been raised by manufacturers and service providers on the data fields of register 40_{16}. The figure provided in this WP is a general example for the loading of data in that register. Hopefully, it will clarify the differences between the FMS selected altitude and the FCU/MCP selected altitude and how the FCU/MCP mode bits as well as those related to the target altitude should be set depending on the phase of flight.

It is proposed to add this figure in the new appendix C of Doc NNNN.

1. INTRODUCTION

A lot of questions have been raised by manufacturers and service providers on the data fields of register 40_{16}. The figure provided in this WP is a general example for the loading of data in that register. Hopefully, it will clarify the differences between the FMS selected altitude and the FCU/MCP selected altitude and how the FCU/MCP mode bits as well as those related to the target altitude should be set depending on the phase of flight.

2. GENERAL EXAMPLE FOR THE LOADING OF DATA IN REGISTER 40_{16}

The figure in attachment 1 provides a general example for the loading of data in register 40_{16}. It lists a number of hypothesis to support the example.

Its goal is to clarify the differences between the FMS selected altitude and the FCU/MCP selected altitude and also to clarify how the target altitude of the aircraft is determined depending on the phase of flight in the vertical profile.

More detailed information for the loading of data in register 40_{16} is already provided in appendix C of Doc NNNN for some Airbus and Boeing platforms.

3. PROPOSAL

If the WG-B agrees that the figure is useful, it is proposed to include it in the new appendix C of Doc NNNN (implementation guidelines) as follows:

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C.2.1.4.3 TRANSPONDER REGISTER NUMBER 40_{16}

C.2.1.4.3.1 *General example for the loading of data in register 40_{16}*

Figure C-1 provides a general example for the loading of data in register 40_{16}. It lists a number of hypothesis to support the example.

Paragraphs C.2.1.4.3.2, C.2.1.4.3.3 and C.2.1.4.3.4 provide more detailed information for some specific platforms.

Its goal is to clarify the differences between the FMS selected altitude and the FCU/MCP selected altitude and also to clarify how the target altitude of the aircraft and the MCP/FCU mode bits are determined depending on the phase of flight in the vertical profile.

<Insert here the figure of attachment 1>

Figure C-1: General example for the loading of data in register 40_{16}

C.2.1.4.3.2 *Transponder register number 40_{16} on Airbus aircraft*

<Editorial note: figure C-1 of this paragraph should be renumbered figure C-2>

C.2.1.4.3.3 *Transponder register number 40_{16} on Boeing 747-400, 757 and 767 aircraft*

C.2.1.4.3.4 *Setting of the target altitude source bits (bits 54-56)*

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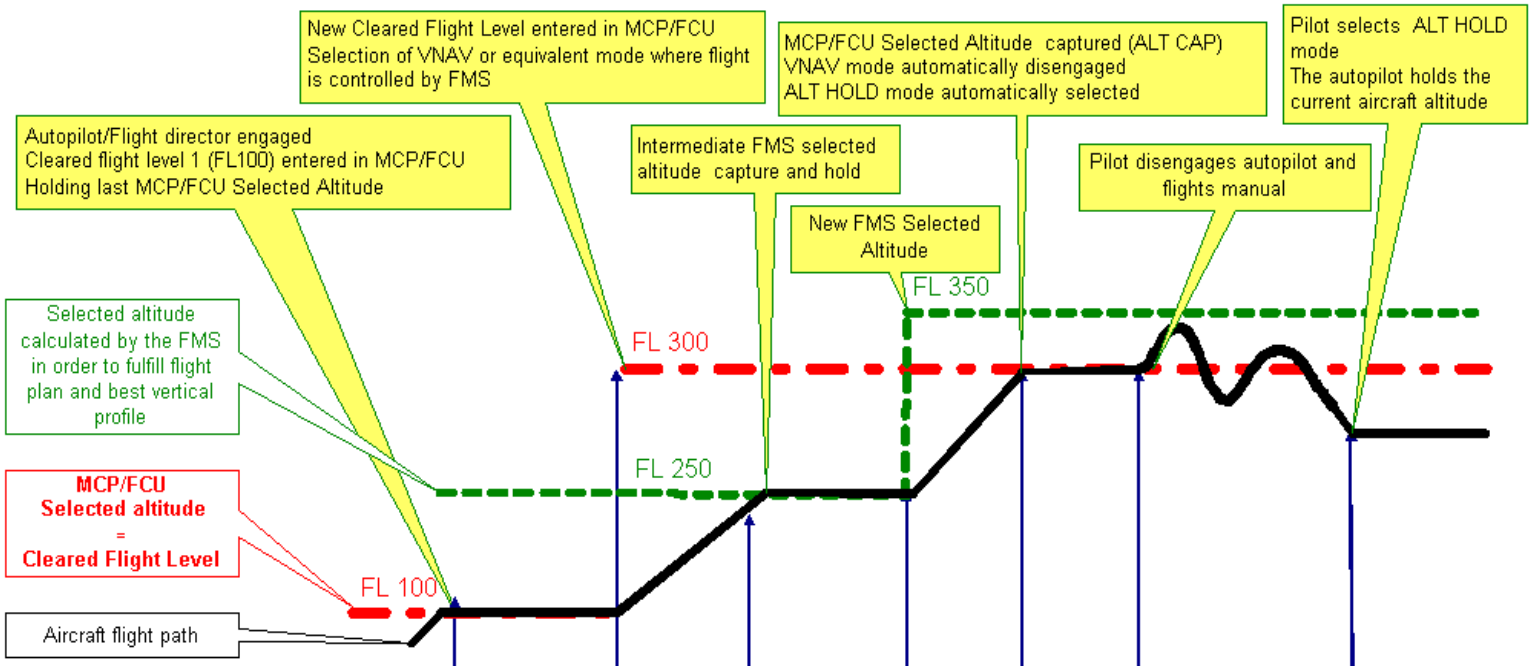
A CP is proposed with the above amendments in attachment 2.

4. CONCLUSION

The meeting is invited to consider the above proposal. If the WG-B agrees with the CP, the latter will be inserted in appendix C of Doc NNNN in the version of the document provided to the secretariat, shortly after this meeting, for publication.

Attachment 1: General example for the loading of data in register 40_{16}

Hypothesis on information available to transponder
The FMS selected altitude (calculated by the FMS) and the target altitude source information are available on aircraft buses (this is not necessary the case today) as well as the MCP/FCU mode bits. Bits 48 and 54 are set to 1 all the time with this hypothesis. The reverse hypothesis would require bits 48-51 and bits 54-56 to be all set to 0 and the FMS selected altitude field to be all zeroed.



Register 40Hex content	MCP/FCU Selected Altitude		100	300	300	300	300	300	300
	FMS Selected Altitude		250	250	250	350	350	350	350
	MCP/FCU Mode bits	Provided	1	1	1	1	1	1	1
		VNAV	0	1	1	1	0	0	0
		Alt Hold	1	0	0	0	1	0	1
		Approach	0	0	0	0	0	0	0
	Target altitude (Unknown, Altitude,FCU/MCP, FMS)		FCU/MCP	FMS	FMS	FCU/MCP	FCU/MCP	Altitude	Altitude

Attachment 2

Proposed Changes to: Doc NNNN (to be included in the first publication of the document)

Submit to: Rapporteur, ASP Working Group B Page 1 of 1

1. Change No __(Assigned by Rapporteur) Date submitted: May 2006

Title: **CP to include in Appendix C of Doc NNNN an example for the loading of data in register 40_{16}**

2. List of all relevant ASP WGB Working Papers
WP B10-30 (this WP)

3. Background:
A lot of questions have been raised by manufacturers and service providers on the data fields of register 40_{16}. Various and sometimes contradictory implementations of register 40_{16} have been observed with the implementation of Enhanced Surveillance in Europe.

4. Need for change:
It is proposed to add a figure providing a general example for the loading of data in that register. Hopefully, it will clarify the differences between the FMS selected altitude and the FCU/MCP selected altitude and how the FCU/MCP mode bits as well as those related to the target altitude should be set depending on the phase of flight.

5. Change:
As proposed in section 3 of WP B10-30 (this WP).

6. Priority: (confirmed by Rapporteur)

	1. Addition	-	New material
	2. Update	-	Technical change or correction to document
X	2. Useful	-	Will enhance understanding of the document
	3. Cosmetic	-	Needed to correct editorial error

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