EUROCAE WG-49

RTCA SC-209

TITLE: Review of "Generic test procedures for enhanced surveillance" As presented in WG49N7-6a (attached)

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<u>SUMMARY</u>

This document reviews the procedures and data values provided in Working Paper WG49N7-6a and addresses Action Item A6/15. Commentary and Data Value Changes are provided in the attached WG49N7-6a and are presented in Bold Blue Font.
(rhs_09/24/2006)

EUROCAE WG-49

TITLE: Generic test procedures for enhanced surveillance

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SUMMARY

This paper proposes generic test procedures to verify that data is correctly loaded into the fields of register 10_{16} which are not managed by the transponder function and into transponder registers 40_{16}, 50_{16} and 60_{16} and applies the defined test procedures to aircraft equipped with ARINC data buses.

Introduction

This paper proposes generic test procedures to verify that data is correctly loaded into the fields of register 10_{16} which are not managed by the transponder function and into transponder registers 40_{16}, 50_{16} and 60_{16} and applies the defined test procedures to aircraft equipped with ARINC data buses.

The transponder manufacturers and the certification authorities will be encouraged to use these test procedures to check that the transponder meets the requirements for the enhanced surveillance and/or ADS-B mandates.

===================== Proposed new text in EUROCAE ED-101 ==========================

CHAPTER 5

MINIMUM PERFORMANCE SPECIFICATION

3.1 INTRODUCTION

3.1.1 Mode S Specific Service Applications

The specification for each application in this document is completely contained in a single subsection of this chapter and the testing for that application is given the same subsection number in Chapter 5. New applications will be added when they have been defined and a requirement for them has been agreed.
Each subsection in Chapter 3 will start with an introduction giving brief reasons for producing MOPS for the application described in that subsection.

If individual tests are needed in Chapters 4 and 6 for a particular application, these are listed in tabular form with the table number the same as the application subsection number in chapters 3 and 5.

The following table provides the list of transponder registers which are defined by ICAO, the applications which make use of the registers (ADS-B, Elementary Surveillance and/or Enhanced Surveillance), the EUROCAE documents which specify the registers and their associated test procedures:

Transponder register No.	Assignment	Application	Reference Document	Applicable Procedure
00_{16}	Not valid	Reserved for AICB	ED-73B	§5.5.8 Procedure 18
01_{16}	Unassigned			
02_{16}	Linked Comm-B, segment 2	Reserved for AICB	ED-73B	§5.5.8 Procedure 18
03_{16}	Linked Comm-B, segment 3	Reserved for AICB	ED-73B	§5.5.8 Procedure 18
04_{16}	Linked Comm-B, segment 4	Reserved for AICB	ED-73B	§5.5.8 Procedure 18
05_{16}	Extended squitter airborne position	ADS-B		
06_{16}	Extended squitter surface position	ADS-B		
07_{16}	Extended squitter status	ADS-B		
08_{16}	Extended squitter identification and type	ADS-B		
09_{16}	Extended squitter airborne velocity	ADS-B		
$0A_{16}$	Extended squitter event-driven information	ADS-B		
$0B_{16}$	Air/air information 1 (aircraft state)	ADS-B		
$0C_{16}$	Air/air information 2 (aircraft intent)	ADS-B		
$0D_{16}$-$0E_{16}$	Reserved for air/air state information			
$0F_{16}$	Reserved for ACAS			
10_{16}	Data link capability report	ELS/EHS	ED-73 B ED-101A	§5.5.8 Procedure §5.3 Procedure 9-10
11_{16}-16_{16}	Reserved for extension to datalink capability reports			
17_{16}	Common usage GICB capability report	ELS/EHS	ED-101A	§5.3 Procedure 10
18_{16}-$1C_{16}$	Common usage GICB capability report	EHS	ED-101A	§5.3 Procedure 9-10
$1D_{16}$	Common usage GICB capability report	EHS	ED-101A	§5.3 Procedure 9
$1E_{16}$-$1F_{16}$	Mode S specific services capability reports		ED-101A	
20_{16}	Aircraft identification	ELS	ED-73B	§5.5.8 Procedure 19
21_{16}	Aircraft and airline registration markings			
22_{16}	Antenna positions			
23_{16}	Reserved for antenna position			
24_{16}	Reserved for aircraft parameters			
25_{16}	Aircraft type			
26_{16}-$2F_{16}$	Unassigned			
30_{16}	ACAS active resolution advisory	~~ELS~~	ED-73B	§5.5.8 Procedure 31,31A
31_{16}-$3F_{16}$	Unassigned			
40_{16}	Selected vertical intention	EHS	ED-101A	§5.3 Procedure 10-11
41_{16}	Next waypoint identifier			
42_{16}	Next waypoint position			
43_{16}	Next waypoint information			

Transponder register No.	Assignment	Application	Reference Document	Applicable Procedure
44_{16}	Meteorological routine air report			
45_{16}	Meteorological hazard report			
46_{16}	Reserved for flight management system Mode 1			
47_{16}	Reserved for flight management system Mode 2			
48_{16}	VHF channel report			
49_{16}-$4F_{16}$	Unassigned			
50_{16}	Track and turn report	EHS	ED-101A	§5.3 Procedure 10
51_{16}	Position report coarse			
52_{16}	Position report fine			
53_{16}	Air-referenced state vector			
54_{16}	Waypoint 1			
55_{16}	Waypoint 2			
56_{16}	Waypoint 3			
57_{16}-$5E_{16}$	Unassigned			
$5F_{16}$	Quasi-static parameter monitoring			
60_{16}	Heading and speed report	EHS	ED-101A	§5.3 Procedure 10
61_{16}	Extended squitter emergency/priority status	ADS-B		
62_{16}	Reserved for target state and status information	ADS-B		
63_{16}	Reserved for extended squitter	ADS-B		
64_{16}	Reserved for extended squitter	ADS-B		
65_{16}	Extended squitter Aircraft operational status	ADS-B		
66_{16}-$6F_{16}$	Reserved for extended squitter	ADS-B		
70_{16}-75_{16}	Reserved for future aircraft downlink parameters			
76_{16}-$E0_{16}$	Unassigned			
$E1_{16}$-$E2_{16}$	Reserved for Mode S BITE			
$E3_{16}$	Transponder type/part number			
$E4_{16}$	Transponder software revision number			
$E5_{16}$	ACAS unit part number			
$E6_{16}$	ACAS unit software revision number			
$E7_{16}$-$F0_{16}$	Unassigned			
$F1_{16}$	Military applications			
$F2_{16}$	Military applications			
$F3_{16}$-FF_{16}	Unassigned			

3.1.2 Equipment

3.2 DATAFLASH APPLICATION

3.3 EUROPEAN ENHANCED SURVEILLANCE APPLICATION

3.3.1 Introduction

The EUROCONTROL ATM 2000+ Strategy confirmed that Enhanced Surveillance (EHS) was essential to safely enable additional traffic growth. Therefore, in the face of continuing traffic growth, Mode S EHS has been mandated for civil registered aircraft from 31 March 2005 in Germany and the United Kingdom, and with effect from 31 March 2007 in France for aircraft considered to be EHS capable.

The European Enhanced Surveillance application entails the use of eight Downlink Aircraft Parameters (DAPs) for initial implementation, as follows:

- Magnetic Heading
- Indicated Airspeed and/or Mach No.
- Vertical Rate (climb/descend)
- FCU/MCP Selected Altitude
- Ground Speed
- Roll Angle
- Track Angle Rate (or True Airspeed if Track Angle Rate is not available)
- True Track Angle

These DAPS are embedded in three transponder registers (40_{16}, 50_{16}, 60_{16}). The data format requirements for these three registers are defined in sections 3.3.2.5, 3.3.2.6 and 3.3.2.7 respectively.

In addition to those three registers, the European Enhanced Surveillance application uses a number of capability report registers to assess the real time ability of the aircraft to transmit DAPs. The format requirements related to the European Enhanced Surveillance application for these capability registers are defined in sections 3.3.2.1 through 3.3.2.4.

The European Enhanced Surveillance application presents the following benefits:

- The provision of actual aircraft derived data, such as Magnetic Heading, Air Speed, Selected Altitude and Vertical Rate, enables controllers to reduce the radio telephony (RT) workload and better assess the separation situations.

- EHS enables Monitoring Tools and Safety Nets, which work on actual data, to be implemented or improved (eg. Short Term Conflict Alert) which, in turn, will allow safety levels to be maintained or improved despite the increase in traffic levels.

3.3.2 Transponder register data format

3.3.2.1 Register 10_{16}

3.3.2.1.1 Register 10_{16} Mode S subnetwork version number (bit 17-23)

In order to indicate which format is used to encode transponder registers, the Mode S subnetwork version number shall be set to the corresponding version of Annex 10 which is used for the formatting of the registers.

The minimum version number required for the European Enhanced Surveillance application shall be version 3 if the register tables are using the formats specified in Amendment 77 of Annex 10 or version 4 if the register tables are using the formats specified in Amendment 81 of Annex 10 and edition 1 of Doc 9871.

3.3.2.1.2 Register 10_{16} Mode S specific services capability (bit 25)

Register 10_{16} bit 25 shall indicate that at least one Mode S specific service (transponder register application, MSP applications or broadcast service) is supported and the particular capability report shall be checked.

RHS Comment:
Probably should use the same wording as provided in ICAO Doc 9871 for BDS 4,0 regarding bit 25, as it is more specific. e.g.,

ICAO Doc. 9871, Table A-2-16, Note 2) provides the following:

"When bit 25 is set to 1, it shall indicate that at least one Mode S Specific Service (other than GICB services related to registers 02_{16}, 03_{16}, 04_{16}, 10_{16}, 17_{16} to $1C_{16}$, 20_{16} and 30_{16}) is supported and the particular capability reports shall be checked.

Note.---Registers accessed by BDS codes 0,2; 0,3; 0,4; 1,0; 1,7 to 1,C; 2,0 and 3,0 do not affect the setting of bit 25."

3.3.2.1.3 Register 10_{16} Common usage GICB capability report (bit 36)

Bit 36 shall be toggled each time the common usage GICB capability report (register 17_{16}) changes.

To avoid the generation of too many broadcast of the capability report changes, register 17_{16} shall be sampled at approximately one minute intervals to check for change.

3.3.2.2 Register 17_{16} Common usage GICB capability report

A system supporting the European Enhanced Surveillance application shall support register 17_{16} to indicate common usage GICB services currently supported.

Each bit position indicates that there is at least one valid data loaded in the corresponding register. These bits are dynamic.

For the European Enhanced Surveillance application, the management of bit 7 (register 20_{16} aircraft identification), bit 9 (register 40_{16} selected vertical intention), bit 16 (register 50_{16} track and turn report) and bit 24 (register 60_{16} heading and speed report) shall be implemented.

3.3.2.3 Register 18_{16} to $1C_{16}$

Register 18_{16} to $1C_{16}$ shall be implemented and shall indicate which transponder register have been implemented in the aircraft installation. For the European Enhanced Surveillance application, bits 49, 33 and 17 shall be set. The setting of these bits are static and shall not change during the operation of the transponder when the inputs disappear.

3.3.2.4 Register $1D_{16}$

The system shall indicate its data-flash capability in bit 6 and 31 of register $1D_{16.}$ There is not requirement to implement data-flash therefore these bits shall be at least set to 0.

3.3.2.5 Register 40_{16} data format

Table 3.3-1 lists all requirements related to the formatting of register 40_{16}.

RHS Comment:
Review and consideration of Working Paper SC209-WP-04_07 should be completed prior to completing BDS 4,0 as the working paper deals with Updates to BDS 4,0 Issues.

Table 3.3-1: BDS 4,0 — Selected vertical intention

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 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

MB FIELD

3.3.2.6 Register 50_{16} data format

Table 3.3-2 lists all requirements related to the formatting of register 50_{16}.

Table 3.3-2: BDS code 5,0 — Track and turn report

MB FIELD

1	STATUS
2	Sign 1 = Left wing down
3	MSB = 45 degrees
4	
5	
6	ROLL ANGLE
7	
8	Range [-90, 90] degrees
9	
10	
11	LSB = 45/256 degrees
12	STATUS
13	SIGN 1 = West (e.g. 315 = -45º)
14	MSB = 90 degrees
15	
16	
17	TRUE TRACK ANGLE
18	
19	
20	Range [-180, 180] degrees
21	
22	
23	LSB = 90/512 degrees
24	STATUS
25	MSB = 1 024 kt
26	
27	
28	GROUND SPEED
29	
30	
31	Range [0, 2 046] kt
32	
33	
34	LSB = 1 024/512 kt
35	STATUS
36	SIGN 1= Minus
37	MSB = 8 degrees/second
38	
39	
40	TRACK ANGLE RATE
41	
42	Range [-16, 16] degrees/second
43	
44	
45	LSB = 8/256 degrees/second
46	STATUS
47	MSB = 1 024 kt
48	
49	
50	TRUE AIRSPEED
51	
52	
53	Range [0, 2 046] kt
54	
55	
56	LSB = 2 kt

PURPOSE: To provide track and turn data to the ground systems:

1) If the value of a parameter from any source exceeds the range allowable in the register definition, the maximum allowable value in the correct positive or negative sense shall be used instead.

Note:- This requires active intervention by the GFM.

2) The data entered into the register shall, whenever possible, be derived from the sources that are controlling the aircraft.

3) If any parameter is not available on the aircraft, all bits corresponding to that parameter shall be actively set to zero by the BDS servicing process.

4) The LSB of all fields shall be obtained by rounding.

3.3.2.7 Register 60_{16} data format

Table 3.3-3 lists all requirements related to the formatting of register 60_{16}.

Table 3.3-3: BDS code 6,0 — Heading and speed report

MB FIELD

1	STATUS
2	SIGN 1=West (e.g. 315 = -45°)
3	MSB = 90 degrees
4	
5	
6	MAGNETIC HEADING
7	
8	
9	Range = [-180, +180]
10	
11	
12	LSB = 90/512 degrees
13	STATUS
14	MSB = 512 kt
15	
16	
17	INDICATED AIRSPEED
18	
19	
20	Range = [0, 1023]
21	
22	
23	LSB = 512/512 1 kt
24	STATUS
25	MSB = 2.048 MACH
26	
27	
28	MACH
29	
30	
31	Range = [0,4.092] MACH
32	
33	
34	LSB = 2.048/512 MACH
35	STATUS
36	SIGN 1=Below
37	MSB = 8 192 ft/min
38	
39	
40	BAROMETRIC ALTITUDE RATE
41	
42	Range = [-16384, 16 352] ft/min
43	
44	
45	LSB = 8 192/256 = 32 ft/min
46	STATUS
47	SIGN 1= Below
48	MSB = 8 192 ft/min
49	
50	INERTIAL VERTICAL VELOCITY
51	
52	
53	Range =[-16 384 to +16 352] ft/min
54	
55	
56	LSB = 8 192/256 = 32 ft/min

PURPOSE: To provide heading and speed data to ground systems

1) If the value of a parameter from any source exceeds the range allowable in the register definition, the maximum allowable value in the correct positive or negative sense shall be used instead.

Note.— This requires active intervention by the GFM.

2) The data entered into the register shall whenever possible be derived from the sources that are controlling the aircraft.

3) The LSB of all fields shall be obtained by rounding.

3.3.3 European Enhanced Surveillance Application Requirement/Test Cross Reference Table

Table 3.3-4 lists all requirements of the European Enhanced Surveillance Application and gives the test section procedures which test each requirement.

Requirement Paragraph No	Headline	Test chapter paragraph No	Related test
3.3.2	Transponder register data format		Headline
3.3.2.1	Register 10_{16}		Headline
3.3.2.1.1	Register 10_{16} Mode S subnetwork version number (bit 17-23)	5.3.3.1	Procedure 9
3.3.2.1.2	Register 10_{16} Mode S specific services capability (bit 25)	5.3.3.1 and 5.3.3.2.1	Procedure 9 and procedure 10 step 1
3.3.2.1.3	Register 10_{16} Common usage GICB capability report (bit 36)	5.3.3.2.1	Procedure 10 steps 1 and 4
3.3.2.2	Register 17_{16} Common usage GICB capability report	5.3.3.1 and 5.3.3.2.1	Procedure 9 and procedure 10 steps 1, 4 and 5
3.3.2.3	Register 18_{16} to $1C_{16}$	5.3.3.1 and 5.3.3.2.1	Procedure 9 and procedure 10 steps 1 and 4
3.3.2.4	Register $1D_{16}$	5.3.3.1	Procedure 9
3.3.2.5	Register 40_{16} data format (excluding mode field bits 48-56)	5.3.3.2.1	Procedure 10 steps 2 and 3
3.3.2.5	Mode field bits 48-56 of register 40_{16} data format	5.3.3.2.2	Procedure 11
3.3.2.6	Register 50_{16} data format	5.3.3.2.1	Procedure 10 steps 2 and 3
3.3.2.7	Register 60_{16} data format	5.3.3.2.1	Procedure 10 steps 2 and 3

Table 3.3-4: European Enhanced Surveillance Application Requirement/Test Cross-Reference

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CHAPTER 5

TEST PROCEDURES FOR AIRBORNE SYSTEM

5.1 GENERAL

5.2 DATAFLASH APPLICATION

Note : Test Procedures #1 to #8 are defined in that section, the numbering will therefore starts at #9 for the new ones.

5.3 EUROPEAN ENHANCED SURVEILLANCE APPLICATION

5.3.1 Test Equipment

The following test equipment is required:

- A transponder test set.
- A means (referenced hereafter as "aircraft data generator") to input and record aircraft data at the transponder interfaces from simulated aircraft data buses at various input rates.
- A means to interrogate the Mode S transponder at a regular rate between 6 and 10 seconds with surveillance interrogations and decode the replies.
- A means to extract air initiated and broadcast messages announced by the transponder, and extract the data from the transponder registers, by means of interrogations with the appropriate control codes set.

5.3.2 Definitions

- Aircraft data: data available on the aircraft buses with a format which depends on the aircraft architecture. For a great majority of commercial aircraft, the format will rely on ARINC data characteristics.
- Register field: a register field may contain reformatted aircraft data or mode bits indicating which system is controlling the aircraft flight.
- Host register: the transponder register with a data field into which the injected aircraft data will potentially be loaded.

5.3.3 Test Procedures

These test procedures verify that the European enhanced surveillance application is correctly implemented in the Mode S transponder which is only one component of the aircraft installation. They do not verify that the complete installation of the aircraft meet the requirements of the European enhanced surveillance application.

5.3.3.1 Procedure #9 - Test of Mode S Subnetwork Version Number and Global Capability Reporting

Extract register 10_{16}

Verify that

Bit17-23 ~~>~~= 3 (for an Annex 10 amendment 77 transponder), =4 (for an Annex 10 amendment 81 and Doc 9871 edition 1 transponder), >4 (for future amendments of Annex 10 and future editions of Doc 9871)

Bit 25 =1

RHS Comment: Should provide commentary on Version Number not being part of the original ELS/EHS mandates as the request to use the version number was not presented until the ICAO SCRSP TSG in Ft. Lauderdale in February 2005. Therefore, units fielded in order to meet the initial 2003 and 2005 mandates will not have the version number set to anything other than zero.

Inject all data used to fill register 40_{16}, 50_{16} and 60_{16}

Reset the transponder (in order to take into account dynamic check at start-up)

Extract register 17_{16}

Verify that
Bit 9 = 1
Bit 16 = 1
Bit 24 = 1

Extract register $1D_{16}$

Verify that
Bit 6 = 0 and bit 31 = 0 if no dataflash application supported
Bit 6 =1 and bit 31 = 1 if dataflash application is supported

Extract register 19_{16}

Verify that
Bit 49 = 1
Bit 33 = 1
Bit 17 = 1

Stop injection of all data with the aircraft data generator

Extract register 17_{16}

Verify that
Bit 9= 0
Bit 16 = 0
Bit 24 = 0

Extract register 19_{16}

Verify that
Bit 49 = 1
Bit 33 = 1
Bit 17 = 1

5.3.3.2 Generic Test Procedures for Data Formatting and Capability Reporting

The GFM (General Format Manager) is described in section 2.5 of appendix 1 to chapter 5 of Annex 10 Volume III and is capable of the following generic functions:

- read specific aircraft data from a specified avionics bus,
- extract the pertinent data,
- check validity, if invalid or out of date, use alternative source (in case automatic selection is enabled) or load the transponder register field related to the particular label will all ZEROs,
- possibly reformat the data,
- load the data into the related transponder register at the required rate,
- repeatedly updates the common usage GICB Capability Report (transponder register $17_{\mathbf{16}}$) checking periodically the availability of the related ARINC words.
- repeatedly updates the Data Link Capability Report (transponder register 10_{16}) as required
- properly establish Mode-S Specific Services Capability Reports (transponder registers 18_{16} through $1C_{16}$) as required
- ensure that data entered into the transponder registers is properly rounded to maintain an accuracy of +/- ½ Least Significant Bit (LSB).

The following sections propose test procedures to verify that the above generic functions are correctly implemented.

Test approach

Generic test procedures are developed for all aircraft data which can potentially have the following characteristics:

- Unsigned/signed aircraft data.
- Aircraft data with a data range exceeding or not the data range of the register field in which it will be loaded.

- Aircraft data with a better or lower resolution than the register field in which it will be loaded.

Depending on the characteristics of a given airborne parameter, some steps of the generic test procedure will be skipped.

Generic test procedures are related to a given aircraft data being loaded in a given field of a given register, e.g. ARINC label 320 (Magnetic Heading) being loaded in the Magnetic Heading field of register 60_{16}. If register 53_{16} was part of the enhanced surveillance mandate, this test procedure should be repeated when loading the same data in the equivalent field of register 53_{16}.

The generic test procedures should therefore be repeated:

- For all aircraft data parameters which are available and can potentially be loaded in the enhanced surveillance registers.
- For each enhanced surveillance host register field which may contain the aircraft data.
- For each combination of data sources which can provide the airborne parameter.

5.3.3.2.1 Procedure #10 - Transfer of aircraft data available at the transponder interface into the register field

This procedure verifies that aircraft data available at the transponder interface is correctly handled by the transponder and loaded correctly in the field of the register hosting the data (host register).

For this purpose, the following aircraft data values will be used for the test:

- MaxValue: a value which will be used to test that a value greater than the maximum value of the register field leads to set the maximum value of the register field.
- MinValue: a value which will be used to test that a value less than the minimum value of the register field leads to set the minimum value of the register field (the MinValue, depending on the data characteristics may or may not be signed).
- RoundingValues: three values which will be used to test that values with a better resolution than the register field are rounded and not truncated when loaded in that field (e.g. a value with 3/4 LSB leading to round the data to the value immediately above, a value with 1/4 LSB leading to round the data to the value immediately below, a value with 1/2 LSB leading to round the data to the value immediately above).
- BasicValues: 5 basic values which are representative of the register field range (excluding the maximum and minimum value) to test that the data is correctly formatted into the register field. For signed aircraft data, the basic values will include negative values.
- InvalidValue: any basic value with the status bits of aircraft data indicating invalid data.

Additional aircraft data values are used for the testing of the barometric pressure setting field of register 40_{16}:

- BaroMaxValue: a value to test that when the barometric pressure setting is greater than 1209.5 mb, the status bit of the register field is set to invalid.
- BaroMinValue: a value to test that when the barometric pressure setting is less than 800 mb, the status bit of the register field is set to invalid.

Some of the above values are non pertinent depending on the characteristics of the aircraft data parameter.

The minimum update rates of the enhanced surveillance transponder registers are the following:

Transponder register No.	*Assignment*	*Minimum update rate*
40_{16}	Selected vertical intention	1.0s
50_{16}	Track and turn report	1.3s
60_{16}	Heading and speed report	1.3s

The following values will be used to test the update rate of the data fields :

- HighUpdateRateValue : a compliant value corresponding to a much faster rate than the required minimum update rate (e.g. 0.2s for register 40_{16}).
- MediumUpdateRateValue : a compliant value corresponding to a rate which is twice faster than the required minimum update rate (e.g. 0.5s for register 40_{16}).

- StandardUpdateRateValue : a compliant value close or equal to the required minimum update rate (e.g. 1.0s for register 40_{16}).
- LowUpdateRateValue : a non compliant value corresponding to a lower update rate than the required minimum update rate (e.g. 1.1s for register 40_{16}).

Example values for registers 40_{16}, 50_{16} and 60_{16}:

Transponder register No.	*40_{16}*	*50_{16}*	*60_{16}*
HighUpdateRateValue	0.2s	0.5s	0.5s
MediumUpdateRateValue	0.5s	0.8s	0.8s
StandardUpdateRateValue	1.0s	1.3s	1.3s
LowUpdateRateValue	1.1s	1.4s	1.4s

This generic test procedure is used for all fields of register 50_{16} and 60_{16}, and for the following fields of register 40_{16}:

- MCP/FCU selected altitude
- FMS selected altitude
- Barometric pressure setting

The mode bits of register 40_{16} (bits 48-51 and 54-56) are tested through a separate test procedure (test procedure #11).

In section 5.3.4.1, some values to be used are proposed for ARINC architectures to check for the correct loading of data in the fields of registers 40_{16}, 50_{16} and 60_{16}.

STEP 1 - Verification that registers 17_{16} and 19_{16} are correctly set

Ensure that the TCAS/Transponder interface is not active.

Note: if the TCAS/Transponder interface is active, TCAS will attempt to load the Data Link Capability Report directly into transponder register 10_{16} which will result in the transponder initiating an Air-Initiated Comm.-B Broadcast message.

Do not inject any data with the aircraft data generator.

Extract register 19_{16} and check that the bit related to the GICB service for the host register is set to 1 (the GICB service is implemented in the aircraft installation but is not necessarily active, these bits will be bit 49, bit 33 and bit 17 for respectively the host registers 40_{16}, 50_{16} and 60_{16}).

Extract register 17_{16} and the host register and verify that they both contain all zeros.

Inject, using the aircraft data generator, the data through the primary data source.

Perform the data injection with an update rate equal to the StandardUpdateRateValue. Do not inject data through the secondary data source.

Inject valid aircraft data set to its MaxValue.

Extract register 17_{16}.

Verify in the MB field of the transponder's reply that register 17_{16} indicates that the bit related to the host register is set to 1 (the associated GICB service is active, i.e. currently supported, these bits will be bit 9, bit 16 and bit 24 for respectively the host registers 40_{16}, 50_{16} and 60_{16}).

Extract register 10_{16}.

Check that bit 25 of register 10_{16} is set to 1 and note the value of bit 36.

STEP 2 - Verification that the aircraft data is correctly extracted, reformatted and loaded

Step 2.1 - Testing of the maximum and minimum values of the register field

Extract the host register.

Verify in the MB field of the transponder's reply that all bits of the register field are set to 1, except, if any, the sign bit (valid data and the register field is set to its maximal value which might be lower than the injected value – the data is truncated).

Inject valid aircraft data set to its MinValue.

Extract the host register.

Verify in the MB field of the transponder's reply that all bits of the register field are set to 0 except, if any, the sign bit and the status bit (valid data and the register field is set to its minimal value which might be higher than the injected value – the data is truncated).

Step 2.2 - Testing of the field range

Inject valid aircraft data set to the BasicValues.

For each BasicValue extract the host register.

Verify in the MB field of the transponder's reply that all bits of the parameter field are set to the expected value with a status bit, if any, indicating valid data and a sign bit, if any, appropriately set. If some values are signed, verify that 2's complement representation is used.

Verify that other fields and bits of the register are not affected by the loading of aircraft data in the register field associated to the tested airborne parameter.

Note : for example, for register 40_{16}, if FMS selected altitude data is injected, it shall not affect the content of the MCP/FCU selected altitude field.

(The following verifications of step 2.2 are only made for the barometric pressure setting field of register 40_{16})

Inject valid aircraft data set to BaroMaxValue.

Extract register 40_{16} and verify that the status bit of the barometric pressure setting field (bit 27) is set to 0 (invalid data).

Inject valid aircraft data set to BaroMinValue.

Extract register 40_{16} and verify that the status bit of the barometric pressure setting field (bit 27) is set to 0 (invalid data).

(The following step 2.3 is skipped for aircraft data with a poorer or equal resolution than the host register field)

Step 2.3 - Testing of the rounding of data

Inject valid aircraft data set to the RoundingValues.

For each RoundingValue extract the host register.

Verify in the MB field of the transponder's reply that all bits of the parameter field are set to the expected value (valid data and rounded values).

STEP 3 – Verification that the status bits are correctly handled

Inject all possible combination of the aircraft data status bits which are not indicating valid data.

For each combination extract the host register.

Verify in the MB field of the transponder's reply that the register field status bit, if any, is always set to 0 (invalid data).

Inject valid aircraft data on the primary data source.

Perform the data injection with 3 different update rates equal respectively to the HighUpdateRateValue, MediumUpdateRateValue and the StandardUpdateRateValue.

For each update rate value, extract the host register and verify in the MB field of the transponder's reply that the register field status bit is set to 1 (valid data).

Perform the aircraft data injection with an update rate equal to the LowUpdateRateValue (non compliant update rate).

Extract the host register and verify in the MB field of the transponder's reply that the register field status bit is set to 0 (invalid data).[1]

STEP 4 – Verification that register 17_{16} and register 10_{16} are correctly updated and that register 19_{16} is unchanged

Inject valid aircraft data on the primary data source.

Perform the data injection with an update rate equal to the StandardUpdateRateValue.

Extract register 17_{16}.

Verify in the MB field of the transponder's reply that register 17_{16} indicates that the host register is supported.

Perform the aircraft data injection with a non compliant rate equal to 2s or twice the specified register minimum update rate (whichever is the greater).

Extract register 17_{16}.

Verify in the MB field of the transponder's reply that register 17_{16} indicates that the host register is no longer supported.

Extract register 19_{16}.

Verify in the MB field of the transponder's reply that register 19_{16} still indicates that the GICB service associated to the host register is installed.

Extract the host register.

Verify in the MB field of the transponder's reply that all bits of the parameter field are set to 0.

Perform periodic interrogations using short surveillance interrogations.

Verify that after a certain time (approximately 1 minute), register 10_{16} is broadcasted.

Extract register 10_{16}.

Verify in the MB field of the transponder's reply that the only change in register 10_{16} is the value of bit 36.

Perform the aircraft data injection on the primary data source with an update rate equal to the StandardUpdateRateValue.

Extract register 17_{16}.

Verify in the MB field of the transponder's reply that register 17_{16} indicates that the host register is supported again.

Extract the host register.

Verify in the MB field of the transponder's reply that the register field status bit is set to 1 (valid data).

[1] This requirement (Annex 10 Volume III, § 2.1.1 of appendix 1 to Chapter 5) is under review in conjunction with § 2.5.2 (which is about zeroing the data field).

Perform periodic interrogations using short surveillance interrogations.

Verify that after a certain time (approximately 1 minute), register 10 is broadcasted.

Extract register 10_{16}.

Verify in the MB field of the transponder's reply that the only change in register 10_{16} is again the value of bit 36.

STEP 5 – Verification that the secondary data source is used when selected

Inject, using the aircraft data generator, data through the secondary data source.

Perform the data injection with an update rate equal to the StandardUpdateRateValue.

Inject through this secondary source valid data but with a different value than the data injected through the primary data source.

Extract the host register.

Verify in the MB field of the transponder's reply that the value of the MB field is derived from the aircraft data injected through the primary data source.

Select the secondary data source.

Extract the host register.

Verify in the MB field of the transponder's reply that the value of the MB field is derived from the aircraft data injected through the secondary data source.

Extract register 17_{16}.

Verify in the MB field of the transponder's reply that the content of register 17_{16} is unchanged.

5.3.3.2.2 Procedure #11 - Mode bits of register 40_{16}

The setting of the Mode bits (bits 48-51 and bits 54-56) requires that appropriate industry standards have been established. In order to set these bits appropriately, the GFM must receive information from the Auto Pilot, Vertical Navigation Control, or Flight Management System in order to establish which system has control of the aircraft vertical profile.

RHS Comment:
Review and consideration of Working Paper SC209-WP-04_07 should be completed prior to completing BDS 4,0 as the working paper deals with Updates to BDS 4,0 Issues.

STEP 1 – Verification that the MCP/FCU mode bits and Target Altitude bits are set to 0

Inject, using the aircraft data generator, valid MCP/FCU selected altitude and barometric pressure setting data through the primary data source.

Perform the data injection with an update rate equal to the StandardUpdateRateValue.

Do not inject FMS selected altitude data.

Do not inject any data into the GFM related to the MCP/FCU mode bits (bits 48-51) and to the Target Altitude bits (bits 54-56).

Extract register 40_{16}.

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field and barometric pressure setting field are set to the expected value, and that all bits related to the FMS selected altitude field are set to 0..

Verify in the MB field of the transponder's reply that bits 48-56 are all set to 0.

(The following step 2 is skipped for aircraft architectures using characteristics which have not yet established any standard to provide the MCP/FCU mode bits)

STEP 2 – Verification that the MCP/FCU mode bits are correctly managed

Do not inject any data into the GFM related to the Target Altitude bits (bits 54-56).

Managed vertical mode

Inject data in the GFM indicating that the MCP/FCU mode bits are actively populated (mode information provided) and that the aircraft vertical profile is in managed vertical mode.

Extract register 40_{16}.

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field and barometric pressure setting field are set to the expected value, and that all bits related to the FMS selected altitude field are set to 0.

Verify in the MB field of the transponder's reply that bits 48 and 49 are set to 1 and bits 50-56 are all set to 0.

Altitude hold mode

Inject data in the GFM indicating that the MCP/FCU mode bits are actively populated (mode information provided) and that the aircraft vertical profile is in altitude hold mode.

Extract register 40_{16}.

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field are set to the expected value, and that all bits related to the FMS selected altitude field and barometric pressure setting field are set to 0.

Verify in the MB field of the transponder's reply that bits 48 and 50 are set to 1 and bits 49 and 51-56 are all set to 0.

Approach mode

Inject data in the GFM indicating that the MCP/FCU mode bits are actively populated (mode information provided) and that the aircraft vertical profile is in approach mode.

Extract register 40_{16}.

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field and barometric pressure setting field are set to the expected value, and that all bits related to the FMS selected altitude field are set to 0.

Verify in the MB field of the transponder's reply that bits 48 and 51 are set to 1 and bits 49-50 and 51-56 are all set to 0.

Status of MCP/FCU mode bits

Inject data in the GFM indicating that the MCP/FCU mode bits are not actively populated (no mode information provided).

Extract register 40_{16}.

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field and barometric pressure setting field are set to the expected value, and that all bits related to the FMS selected altitude field are set to 0.

Verify in the MB field of the transponder's reply that bits 48-56 are all set to 0.

(The following step 3 is skipped for aircraft architectures using characteristics which have not yet established any standard to provide the Target Altitude Source bits or for an installation with a GFM which is not receiving any information from the Auto Pilot, Vertical Navigation Control, or Flight Management System in order to establish which system has control of the aircraft vertical profile).

STEP 3 – Verification that the Target Altitude Source bits are correctly managed

Inject, using the aircraft data generator, valid MCP/FCU selected altitude data, valid FMS selected altitude data (a different from the MCP/FCU selected altitude) and valid barometric pressure setting data through the primary data source.

Do not inject any data into the GFM related to the MCP/FCU mode bits (bits 48-51).

Unknown target altitude source

Inject data in the GFM indicating that the Target Altitude Source bits are actively populated (source information provided) and that the aircraft intent with respect to its target altitude is unknown (e.g. the pilot is currently flying the aircraft).

Extract register 40_{16}.

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field, the FMS selected altitude field and the barometric pressure setting field are set to the expected value.

Verify in the MB field of the transponder's reply that bits 48-51 are set to 0, bit 54 is set to 1 and bits 55-56 are set to 00.

Aircraft altitude for the target altitude

Inject data in the GFM indicating that the Target Altitude Source bits are actively populated (source information provided) and that the target altitude of the aircraft (its short term to medium intent) is equivalent to the aircraft altitude (e.g. the aircraft has levelled off).

Extract register 40_{16}.

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field, the FMS selected altitude field and the barometric pressure setting field are set to the expected value.

Verify in the MB field of the transponder's reply that bits 48-51 are set to 0, bit 54 is set to 1 and bits 55-56 are set to 01.

MCP/FCU for the target altitude

Inject data in the GFM indicating that the Target Altitude Source bits are actively populated (source information provided) and that the target altitude of the aircraft (its short term to medium intent) is equivalent to the MCP/FCU selected altitude (e.g. the aircraft vertical profile is only controlled by the Auto Pilot).

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field, the FMS selected altitude field and the barometric pressure setting field are set to the expected value.

Verify in the MB field of the transponder's reply that bits 48-51 are set to 0, bit 54 is set to 1 and bits 55-56 are set to 10.

FMS selected altitude for the target altitude

Inject data in the GFM indicating that the Target Altitude Source bits are actively populated (source information provided) and that the target altitude of the aircraft (its short term to medium intent) is equivalent to the FMS selected altitude (e.g. the aircraft vertical profile is controlled by the FMS, the aircraft is climbing to its FCU/MCP selected altitude as entered in the Auto Pilot but makes intermediate flight levels calculated by the FMS to reach this altitude).

Extract register 40_{16}.

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field, the FMS selected altitude field and the barometric pressure setting field are set to the expected value.

Verify in the MB field of the transponder's reply that bits 48-51 are set to 0, bit 54 is set to 1 and bits 55-56 are set to 11.

Status of Target Altitude Source bits

Inject data in the GFM indicating that the Target Altitude Source bits are not actively populated (no source information provided).

Extract register 40_{16}.

Verify in the MB field of the transponder's reply that all bits of the MCP/FCU selected altitude field, the FMS selected altitude field and the barometric pressure setting field are set to the expected value.

Verify in the MB field of the transponder's reply that bits 48-56 are all set to 0.

RHS Comment:
Perhaps I have missed it, but I do not see any verification of BDS 5,F which is implemented to track changes in BDS 4,0 predominantly.

5.3.4 Application of European Enhanced Surveillance Application Test Procedures to ARINC architectures

5.3.4.1 Application of procedure #10

The following tables (1 table for each register field hosting aircraft data) define the test values which ~~shall~~ can be used for each of the ARINC label from which the aircraft data can potentially be derived for the loading of the matching register field.

Table 5.3-1: Register 40_{16} MCP/FCU Selected Altitude (ARINC label 102)					
Type of Value	Generic MCP/FCU Selected Altitude Input (BNR)		Register 40_{16} MCP/FCU Selected Altitude		
	Status (Note 1)	Data Value (feet)	Status (bit 1)	Decimal Value (feet)	Binary Value (bit 2 ----- 13)
Basic	Valid	43,680.00	1	43,680.00	1010 1010 1010
Basic	Valid	21,840.00	1	21,840.00	0101 0101 0101
Basic	Valid	30,576.00	1	30,576.00	0111 0111 0111
Basic	Valid	48,048.00	1	48,048.00	1011 1011 1011
Basic	Valid	56,784.00	1	56,784.00	1101 1101 1101
Basic	Valid	61,152.00	1	61,152.00	1110 1110 1110
Max	Valid	65,530.00	1	65,520.00	1111 1111 1111
Min	Valid	0.00	1	0.00	0000 0000 0000
Rounded (1/2 LSB)	Valid	21,864.00	1	21,872.00	0101 0101 0111
Rounded (1/4 LSB)	Valid	21,844.00	1	21,840.00	0101 0101 0101
Invalid	Invalid	43,680.00	0	0.00	0000 0000 0000

Table 5.3-2 : Register 40_{16} MCP/FCU Selected Altitude (ARINC label 025)					
Type of Value	Generic MCP/FCU Selected Altitude Input (BCD)		Register 40_{16} MCP/FCU Selected Altitude		
	Status (Note 1)	Data Value (feet)	Status (bit 1)	Decimal Value (feet)	Binary Value (bit 2 ----- 13)
Basic	Valid	43,680.00	1	43,680.00	1010 1010 1010
Basic	Valid	21,840.00	1	21,840.00	0101 0101 0101
Basic	Valid	30,576.00	1	30,576.00	0111 0111 0111
Basic	Valid	48,048.00	1	48,048.00	1011 1011 1011
Max	Valid	50,000.00	1	50,000.00	0110000110101 **1100 0011 0101**
Min	Valid	0.00	1	0.00	0000 0000 0000
Rounded (1/2 LSB)	Valid	21,864.00	1	21,872.00	0101 0101 0111
Rounded (1/4 LSB)	Valid	21,844.00	1	21,840.00	0101 0101 0101
Invalid	Invalid	43,680.00	0	0.00	0000 0000 0000

RHS Comment:
Encoding error shown in Table 5.3-2 appears to be a typographical error.

Table 5.3-3 : Register 40_{16} FMS Selected Altitude (ARINC label TBD)					
Type of Value	Generic FMS Selected Altitude Input (BNR)		Register 40_{16} FMS Selected Altitude		
	Status	Data Value (feet)	Status (bit 14)	Decimal Value (feet)	Binary Value (bit 15 ----- 26)
Basic					
Basic					
Basic					
Basic					
Basic				**Standard not yet established**	
Basic					
Max					
Min					
Rounded (1/2 LSB)					
Rounded (1/4 LSB)					
Invalid					

Table 5.3-4 : Register 40_{16} Barometric pressure (ARINC label 234)					
Type of Value	**ARINC Barometric pressure setting minus 800mb (BCD)**		**Register 40_{16} Barometric pressure setting minus 800mb**		
	Status	**Data Value +800 millibars**	**Status (bit 27)**	**Decimal Value +800 millibars**	**Binary Value (bit 28 ----- 39)**
Basic	Valid	936.50	1	936.50	0101 0101 0101
Basic	Valid	991.10	1	991.10	0111 0111 0111
Max	Valid	1050	1	1050	0100111000100 **1001 1100 0100**
Min	Valid	800	1	0.00	0000 0000 0000
Rounded (1/2 LSB)	NA	NA	NA	NA	NA
Rounded (1/4 LSB)	NA	NA	NA	NA	NA
Invalid	Invalid	991.10	0	0.00	0000 0000 0000
Baro max	NA	NA	NA	NA	NA
Baro min	Valid	750	0	0	0000 0000 0000

RHS Comment:
Encoding error shown in Table 5.3-4 appears to be a typographical error.

Table 5.3-5: Register 50_{16} Roll Angle (ARINC label 325)							
Type of Value	**ARINC Roll Angle (BNR)**			**Register 50_{16} Roll Angle**			
	Status (Note 1)	**Sense**	**Data Value (degrees)**	**Status (bit 1)**	**Sense**	**Decimal Value**	**Binary Value (bit 2 ----- 11)**
Basic	Valid	Left	29.88	1	Left	29.8828	10 1010 1010 **{1} 11 0101 0110**
Basic	Valid	Right	59.94	1	Right	59.94140625	01 0101 0101
Basic	Valid	Left	65.92	1	Left	65.91796875	11 0111 0111 **{2} 10 1000 1001**
Basic	Valid	Left	77.87	1	Left	77.87109375	11 1011 1011 **{3} 10 0100 0101**
Basic	Valid	Right	83.85	1	Right	83.84765625	01 1101 1101
Basic	Valid	Left	41.84	1	Left	41.8359375	10 1110 1110 **{4} 11 0001 1100**
Max	Valid	Left	100	1	Left	90	10 0000 0000 **{5} 10 0000 0001**
Min	Valid	Right	0	1	Right	89,82421875	01 1111 1111
Rounded (1/2 LSB)	Valid	Right	60.21	1	Right	60.29296875	01 0101 0111
Rounded (1/4 LSB)	Valid	Right	59.98	1	Right	59.94140625	01 0101 0101
Invalid	Invalid		0	0	-	0	00 0000 0000

RHS Comment:
Referring to the Roll Angle Table Above, Changes are made in the right hand column in Blue Bold Font. The {X} in front of the changes applies a Case Number. In all five cases above, it appears that the original values were established using Signed Magnitude as opposed to Two's Complement. Using either 2's Complement or pure Angular Weighted Binary (AWB) results in the encodings shown in blue bold font for Case Number 1 –through- 4. Case number 5 shows the maximum negative 2's Complement value or encoding possible for the field.

Table 5.3-6: Register 50_{16} True Track Angle (ARINC label 313)							
Type of Value	ARINC True track Angle (BNR)			Register 50_{16} True track Angle			
	Status (Note 1)	Sign	Data Value (degrees)	Status (bit 12)	Sign	Decimal Value	Binary Value (bit 13 ----- 23)
Basic	Valid	-	120.10	1	-	120.05859375	101 0101 0101
Basic	Valid	+	119.90	1	+	119.8828125	010 1010 1010
Basic	Valid	-	24.10	1	-	24.08203125	111 0111 0111
Basic	Valid	+	167.85	1	+	167.87109375	011 1011 1011
Basic	Valid	-	96.15	1	-	96.15234375	101 1101 1101
Basic	Valid	-	48.15	1	-	48.1640625	110 1110 1110
Basic	Valid	-	0,20	1	-	0,17578125	111 1111 1111
Basic	Valid	+	0	1	+	0	000 0000 0000
Rounded (1/2 LSB)	Valid	+	60.25	1	+	60.29296875	001 0101 0111
Rounded (1/4 LSB)	Valid	+	60.00	1	+	59.94140625	001 0101 0101
Invalid	Invalid		0	0		0	000 0000 0000

Table 5.3-7: Register 50_{16} True Track Angle (ARINC label 013)						
Type of Value	ARINC True track Angle (BCD)		Register 50_{16} True track Angle			
	Status (Note 1)	Data Value (degrees)	Status (bit 12)	Sens	Decimal Value	Binary Value (bit 13 ----- 23)
Basic	Valid	239.9	1	-	120.05859375	101 0101 0101
Basic	Valid	119.90	1	+	119.8828125	010 1010 1010
Basic	Valid	335.9	1	-	24.08203125	111 0111 0111
Basic	Valid	167.85	1	+	167.87109375	011 1011 1011
Basic	Valid	263.8	1	-	96.15234375	101 1101 1101
Basic	Valid	311.8	1	-	48.1640625	110 1110 1110
Max	Valid	359,9	1	-	0,17578125	111 1111 1111
Min	Valid	0	1	+	0	000 0000 0000
Rounded (1/2 LSB)	Valid	60.25	1	+	60.29296875	001 0101 0111
Rounded (1/4 LSB)	Valid	60.00	1	+	59.94140625	001 0101 0101
Invalid	Invalid	0	0		0	000 0000 0000

RHS Comment:

The encodings given in the final column are the same as those provided in the last two columns for Table 5.3-6 and Table 5.3-8. However, the values given in Column 3 of Table 5.3-7 are not the same as those provided in Table 5.3-6 and Table 5.3-7. Since the encodings in Table 5.3-6 and Table 5.3-8 are correct, Table 5.3-7 cannot be correct. Recommend that Column 3 of Table 5.3-7 be corrected to be the same as Column 3 in Table 5.3-6 and Table 5.3-8.

Table 5.3-8: Register 50_{16} GNSS Track Angle (ARINC label 103)							
Type of Value	ARINC GNSS track Angle (BNR)			Register 50_{16} GNSS track Angle			
	Status (Note 1)	Sense	Data Value (degrees)	Status (bit 12)	Sense	Decimal Value	Binary Value (bit 13 ----- 23)
Basic	Valid	-	120.05	1	-	120.05859375	101 0101 0101
Basic	Valid	+	119.90	1	+	119.8828125	010 1010 1010
Basic	Valid	-	24.10	1	-	24.08203125	111 0111 0111
Basic	Valid	+	167.85	1	+	167.87109375	011 1011 1011
Basic	Valid	-	96.15	1	-	96.15234375	101 1101 1101
Basic	Valid	-	48.15	1	-	48.1640625	110 1110 1110
Basic	Valid	-	0.2	1	-	0.17578125	111 1111 1111
Basic	Valid	+	0	1	+	0	000 0000 0000
Rounded (1/2 LSB)	Valid	+	60.25	1	+	60.29296875	001 0101 0111
Rounded (1/4 LSB)	Valid	+	60.00	1	+	59.94140625	001 0101 0101
Invalid	Invalid		0	0		0	000 0000 0000

Table 5.3-9: Register 50_{16} Ground Speed (ARINC label 312)					
Type of Value	ARINC Ground speed (BNR)		Register 50_{16} Ground Speed		
	Status (Note 1)	**Data Value (kt)**	**Status (bit 24)**	**Decimal Value (kt)**	**Binary Value (bit 25 ----- 24)**
Basic	Valid	1,364	1	1,364	10 1010 1010
Basic	Valid	682	1	682	01 0101 0101
Basic	Valid	1,774	1	1,774	11 0111 0111
Basic	Valid	1,910	1	1,910	11 1011 1011
Basic	Valid	954	1	954	01 1101 1101
Basic	Valid	1,500	1	1,500	10 1110 1110
Max	Valid	4,096	1	2,046	11 1111 1111
Min	Valid	0	1	0	00 0000 0000
Invalid	Invalid	0	0	0	00 0000 0000

Table 5.3-10: Register 50_{16} GNSS Ground Speed (ARINC label 112)					
Type of Value	ARINC GNSS Ground speed (BNR)		Register 50_{16} GNSS Ground Speed		
	Status (Note 1)	**Data Value (kt)**	**Status (bit 24)**	**Decimal Value (kt)**	**Binary Value (bit 25 ----- 24)**
Basic	Valid	1,364	1	1,364	10 1010 1010
Basic	Valid	682	1	682	01 0101 0101
Basic	Valid	1,774	1	1,774	11 0111 0111
Basic	Valid	1910	1	1,910	11 1011 1011
Basic	Valid	954	1	954	01 1101 1101
Basic	Valid	1,500	1	1,500	10 1110 1110
Max	Valid	3,006	1	2,046	11 1111 1111
Min	Valid	0	1	0	00 0000 0000
Rounded (1/2 LSB)	Valid	683	1	684	001 0101 0111 **001 0101 0110**
Rounded (1/4 LSB)	Valid	682.5	1	682	001 0101 0101
Invalid	Invalid	0	0	0	00 0000 0000

RHS Comment:

For the input value of 683, the encoding should round to 156 Hex as opposed to the 157 Hex originally shown in Table 5.3-10 above.

Table 5.3-11: Register 50_{16} Ground Speed (ARINC label 012)					
Type of Value	ARINC Ground speed (BCD)		Register 50_{16} Ground Speed		
	Status (Note 1)	**Data Value (kt)**	**Status (bit 24)**	**Decimal Value (kt)**	**Binary Value (bit 25 ----- 24)**
Basic	Valid	1,364	1	1,364	10 1010 1010
Basic	Valid	682	1	682	01 0101 0101
Basic	Valid	1,774	1	1,774	11 0111 0111
Basic	Valid	1,910	1	1,910	11 1011 1011
Basic	Valid	954	1	954	01 1101 1101
Basic	Valid	1,500	1	1,500	10 1110 1110
Max	Valid	3,006	1	2,046	11 1111 1111
Min	Valid	0	1	0	00 0000 0000
Rounded (1/2 LSB)	Valid	683	1	684	01 0101 0111 **01 0101 0110**
Rounded (1/4 LSB)	Valid	N/A	1		
Invalid	Invalid	0	0	0	00 0000 0000

RHS Comment:

For the input value of 683, the encoding should round to 156 Hex as opposed to the 157 Hex originally shown in Table 5.3-11 above.

Table 5.3-12 Register 50_{16} Track Angle Rate(ARINC label 335)							
Type of Value	ARINC Track angle rate (BNR)			Register 50_{16} Track angle rate			
	Status (Note 1)	Sense	Data Value (Degrees)	Status (bit 35)	Sense	Decimal Value (Degrees)	Binary Value (bit 36 ----- 45)
Basic	Valid	-	10.68	1	-	10.6875	10 1010 1010
Basic	Valid	+	10.65	1	+	10.65625	01 0101 0101
Basic	Valid	-	4.275	1	-	4.28125	11 0111 0111
Basic	Valid	-	2.16	1	-	2.15625	11 1011 1011
Basic	Valid	+	14.91	1	+	14.90625	01 1101 1101
Basic	Valid	-	8.565	1	-	8.5625	10 1110 1110
Basic	Valid	-	0,030	1	-	0.03125	11 1111 1111
Basic	Valid	+	0	1	+	0	00 0000 0000
Rounded (1/2 LSB)	Valid	+	10.68	1	+	10.71875	01 0101 0111 **01 0101 0110**
Rounded (1/4 LSB)	Valid	+	10.665	1	+	10.65625	01 0101 0101
Invalid	Invalid		0	0		0	00 0000 0000

RHS Comment:

For the input value of 10.68, the encoding should round to 156 Hex as opposed to the 157 Hex originally shown in Table 5.3-12 above.

Table 5.3-13: Register 50_{16} True Air Speed (ARINC label 210)					
Type of Value	ARINC True air speed (BNR)		Register 50_{16} Ground Speed		
	Status (Note 1)	Data Value (kt)	Status (bit 24)	Decimal Value (kt)	Binary Value (bit 25 -----34)
Basic	Valid	1,364	1	1,364	10 1010 1010
Basic	Valid	682	1	682	01 0101 0101
Basic	Valid	1,774	1	1,774	11 0111 0111
Basic	Valid	1,910	1	1,910	11 1011 1011
Basic	Valid	954	1	954	01 1101 1101
Basic	Valid	1,500	1	1,500	10 1110 1110
Max	Valid	3,006	1	2,046	11 1111 1111
Min	Valid	0	1	0	00 0000 0000
Rounded (1/2 LSB)	Valid	683.125	1	684	01 0101 0111 **01 0101 0110**
Rounded (1/4 LSB)	Valid	682.625	1	682	01 0101 0101
Invalid	Invalid	0	0	0	00 0000 0000

RHS Comment:

For the input value of 683.125, the encoding should round to 156 Hex as opposed to the 157 Hex originally shown in Table 5.3-13 above.
Note that for input value 3,006, the encoding is the proper maximum value allowed by the field.

Table 5.3-14: Register 50_{16} True Air Speed (ARINC label 230)					
Type of Value	ARINC Ground speed BCD)		Register 50_{16} Ground Speed		
	Status (Note 1)	Data Value (kt)	Status (bit 46)	Decimal Value (kt)	Binary Value (bit 47 ----- 56)
Basic	Valid	340	1	340	00 1010 1010
Basic	Valid	170	1	170	00 0101 0101
Basic	Valid	238	1	238	00 0111 0111
Basic	Valid	374	1	374	00 1011 1011
Basic	Valid	442	1	442	00 1101 1101
Basic	Valid	546		546	01 0001 0001
Basic	Valid	476	1	476	00 1110 1110
Max	Valid	600	1	600	01 0010 1100
Min	Valid	100	1	100	00 0000 0000 **00 0100 0010**
Rounded (1/2 LSB)	Valid	341	1	342	00 1010 1011
Invalid	Invalid	0	0	0	00 0000 0000

RHS Comment:
For the input value of 100, the encoding should be 032 Hex as opposed to 000 Hex originally shown in Table 5.3-14 above. Also, the range for True Airspeed in BDS 5,0 is from 0 –to- (2046-2), so 100 cannot be the minimum value.

Table 5.3-15 Register 60_{16} Magnetic heading (ARINC label 320)							
Type of Value	ARINC Magnetic heading Input (BNR)			Register 60_{16} Magnetic heading			
	Status (Note 1)	Sense	Data Value (degrees)	Status (bit 1)	Sense (bit 2)	Decimal Value (degrees)	Binary Value (bit 3 ----- 12)
Basic	Valid	W	120.05859375	1	W	120.05859375	101 0101 0101
Basic	Valid	E	119.8828125	1	E	119.8828125	010 1010 1010
Basic	Valid	W	24.08203125	1	W	24.08203125	111 0111 0111
Basic	Valid	E	167.87109375	1	E	167.87109375	011 1011 1011
Basic	Valid	W	96.15234375	1	W	96.15234375	101 1101 1101
Basic	Valid	W	48.1640625	1	W	48.1640625	110 1110 1110
Basic	Valid	W	0.16479	1	W	0.17578125	111 1111 1111
Basic	Valid	E	0	1	E	0	000 0000 0000
Rounded (1/2 LSB)	Valid	E	60.25	1	E	60.29296875	001 0101 0111
Rounded (1/4 LSB)	Valid	E	60.00	1	E	59.94140625	001 0101 0101
Invalid	Invalid	E	0	0	E	0	000 0000 0000

Table 5.3-16: Register 60_{16} Magnetic heading (ARINC label 014)							
Type of Value	ARINC Magnetic heading Input (BCD)			Register 60_{16} Magnetic heading			
	Status (Note 1)	Sense	Data Value (degrees)	Status (bit 1)	Sense (bit 2)	Decimal Value (degrees)	Binary Value (bit 3 ----- 12)
Basic	Valid	+	240	1	W	120.05859375	101 0101 0101
Basic	Valid	+	120	1	E	120.05859375	010 1010 1011
Basic	Valid	+	336	1	W	24.08203125	111 0111 0111
Basic	Valid	+	167.8	1	E	167.87109375	011 1011 1011
Basic	Valid	+	263.8	1	W	96.15234375	101 1101 1101
Basic	Valid	+	311.8	1	W	48.1640625	110 1110 1110
Max	Valid	+	359.9	1	W	0.17578125	111 1111 1111
Min	Valid	+	0	1	E	0	000 0000 0000
Invalid	Invalid		0	0		0	0

Table 5.3-17: Register 60_{16} Air Speed (ARINC label 206)					
Type of Value	ARINC Computed Air Speed Input (BNR)		Register 40_{16} Indicated Air Speed		
	Status (Note 1)	Data Value (knots)	Status (bit 13)	Decimal Value (knots)	Binary Value (bit 14 ----- 23)
Basic	Valid	682	1	682	10 1010 1010
Basic	Valid	341	1	341	01 0101 0101
Basic	Valid	887	1	887	11 0111 0111
Basic	Valid	955	1	955	11 1011 1011
Basic	Valid	477	1	477	01 1101 1101
Basic	Valid	750	1	750	10 1110 1110
Max	Valid	1,024	1	1,023	11 1111 1111
Min	Valid	0	1	0	00 0000 0000
Rounded (1/2 LSB)	Valid	342.75	1	343	01 0101 0111
Rounded (1/4 LSB)	Valid	341.25	1	341	01 0101 0101
Invalid	Invalid	0	0	0	00 0000 0000

Table 5.3-18: Register 60_{16} Mach (ARINC label 205)					
Type of Value	**ARINC Mach Input (BNR)**		**Register 40_{16} Mach**		
	Status (Note 1)	**Data Value (mach)**	**Status (bit 24)**	**Decimal Value (mach)**	**Binary Value (bit 25 ----- 34)**
Basic	Valid	1,928	1	1,928	10 1010 1010 **01 1110 0010**
Basic	Valid	1,364	1	1,364	01 0101 0101
Basic	Valid	3,548	1	3,548	11 0111 0111
Basic	Valid	3,820	1	3,820	11 1011 1011
Basic	Valid	1,908	1	1,908	01 1101 1101
Basic	Valid	3,000	1	3,000	10 1110 1110
Max	Valid	4,096	1	4,092	11 1111 1111
Min	Valid	0	1	0	00 0000 0000
Rounded (1/2 LSB)	Valid	1,370	1	1,372	01 0101 0111
Rounded (1/4 LSB)	Valid	1,365	1	1,364	01 0101 0101
Invalid	Invalid	0	0	0	00 0000 0000

RHS Comment:
For the input value of 1.928, the encoding should be 1E2 Hex as opposed to 2AA Hex originally shown in Table 5.3-18 above.
Note that for the input value of 4.096, the encoding of 3FF Hex represents the maximum value possible for the field.

Table 5.3-19: Register 60_{16} Barometric Altitude rate (ARINC label 212)							
Type of Value	**ARINC Baro Alt Rate Input (BNR**			**Register 60_{16} Barometric altitude rate**			
	Status (Note 1)	**Sense**	**Data Value (Ft/min**	**Status (bit 35)**	**Sense (bit 36)**	**Decimal Value (Ft/min**	**Binary Value (bit 37 ----- 45)**
Basic	Valid	+	10,912	1	+	10,912	01 0101 0101
Basic	Valid	-	10,912	1	-	10,912	10 1010 1011
Basic	Valid	-	4,384	1	-	4,384	11 0111 0111
Basic	Valid	-	2,208	1	-	2,208	11 1011 1011
Basic	Valid	+	15,264	1	+	15,264	01 1101 1101
Basic	Valid	-	8,768	1	-	8,768	10 1110 1110
Basic	Valid	-	16,384	1	-	16,384	11 1111 1111 **10 0000 0001**
Basic	Valid	+	16,356	1	+	16,356	01 1111 1111
Rounded (1/2 LSB)	Valid	+	15,248	1	+	15,264	01 1101 1101
Rounded (1/4 LSB)	Valid		NA			NA	NA
Invalid	Invalid		0			0	0

RHS Comment:
For the input value of -16,384, the encoding should be 201 Hex as opposed to 3FF Hex originally shown in Table 5.3-19 above. Note that the encoding of 201 Hex represents the Maximum possible negative value that can be encoded into the field. Taking the 2's complement of 201 Hex results in 1FF Hex which is the maximum possible positive encoding. Taking the 2's complement of 3FF Hex results in 001 Hex which is not correct for the application.

Table 5.3-20: Register 60_{16} Inertial Vertical Velocity (ARINC label 365)							
Type of Value	**ARINC Inertial Vertical Velocity (BNR)**			**Register 60_{16} Inertial Vertical Velocity**			
	Status (Note 1)	**Sense**	**Data Value (Ft/min)**	**Status (bit 46)**	**Sense (bit 47)**	**Decimal Value (Ft/min**	**Binary Value (bit 48 ----- 56)**
Basic	Valid		10,912	1	+	10,912	01 0101 0101
Basic	Valid		10,912	1	-	10,912	10 1010 1011
Basic	Valid		4,384	1	-	4,384	11 0111 0111
Basic	Valid		2,208	1	-	2,208	11 1011 1011
Basic	Valid		15,264	1	+	15,264	01 1101 1101
Basic	Valid		8,768	1	-	8,768	10 1110 1110
Basic	Valid		16,384	1	-	16,384	11 1111 1111 **10 0000 0001**
Basic	Valid		16,356	1	+	16,356	01 1111 1111
Rounded (1/2 LSB)	Valid		15,248	1	+	15,264	01 1101 1101
Rounded (1/4 LSB)	Valid		15,272	1	+	15,264	01 1101 1101
Invalid	Invalid		0	0		0	0

RHS Comment:

For the input value of -16,384, the encoding should be 201 Hex as opposed to 3FF Hex originally shown in Table 5.3-20 above. Note that the encoding of 201 Hex represents the Maximum possible negative value that can be encoded into the field. Taking the 2's complement of 201 Hex results in 1FF Hex which is the maximum possible positive encoding. Taking the 2's complement of 3FF Hex results in 001 Hex which is not correct for the application.

5.3.4.2 Application of procedure #11

<To be completed if any standard exists, maybe for the MCP/FCU mode bits>

5.3.5 Application of European Enhanced Surveillance Application Test Procedures to GAMA architectures

5.3.5.1 Application of procedure #10

5.3.5.2 Application of procedure #11

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