Appendix B
Aircraft Register Formats

DRAFT

Version 2.x

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B. Aircraft Register Formats

B.1 Introduction

Appendix B defines data/message formats of aircraft registers which can be extracted using GICB protocols.

Note — Appendix B is arranged in the following manner:

B.2 Data Formats for Transponder Registers

B.2.1 Ground Initiated Comm B (GICB) Protocol and Processing:

This service consists of defined data available on board the aircraft being put into one of the 255 transponder registers (each with a length of 56 bits) in the Mode S transponder at specified intervals by a serving process, e.g. airborne collision avoidance system (ACAS), aircraft data link processor (ADLP), or an application entity (AE). A Mode S ground interrogator or an ACAS unit can extract the information from any of these transponder registers at any time and pass it for onward transmission to ground based or aircraft applications.

The 8-bit BDS code is determined from the control data. The 7-byte register content is extracted from the received message data. The register content is transferred to the transponder, along with an indication of the specified register number. A request to address one of the air initiated Comm-B registers or the TCAS Active Resolution Advisories Register is discarded.

B.2.2 Register Allocation

Applications shall use the allocated register numbers as shown in the Table B-2-1. The details of the data to be entered into the assigned registers are defined in this §B.3. Table B-2-1 specifies the minimum update rates at which the appropriate transponder register(s) shall be reloaded with valid data. Any valid data shall be reloaded into the relevant register field as soon as it becomes available at the Mode S specific services entity (SSE) interface regardless of the update rate. If data is not available for a time no greater than twice the specified maximum update interval or 2 seconds (whichever is the greater), the status bit (if specified for that field) shall indicate that the data in that field is invalid and the field shall be zeroed. The register number shall be equivalent to the Comm-B data selector (BDS) value used to address that register.

Table B-2-1: GICB Register Number Assignments

Transponder register No.	*Assignment*	*Maximum update interval (see Note 1)*
00_{16}	Not valid	N/A
01_{16}	Unassigned	N/A
02_{16}	Linked Comm-B, segment 2	N/A
03_{16}	Linked Comm-B, segment 3	N/A
04_{16}	Linked Comm-B, segment 4	N/A
05_{16}	Extended Squitter Airborne Position	0.2s
06_{16}	Extended Squitter Surface Position	0.2s
07_{16}	Extended Squitter Status	1.0s
08_{16}	Extended Squitter Identification and Category	15.0s
09_{16}	Extended Squitter Airborne Velocity	1.3s
$0A_{16}$	Extended Squitter Event-driven Information	Variable
$0B_{16}$	Air/air information 1 (aircraft state)	1.3s
$0C_{16}$	Air/air information 2 (aircraft intent)	1.3s
$0D_{16}$-$0E_{16}$	Reserved for air/air state information	To be determined
$0F_{16}$	Reserved for TCAS/ACAS	To be determined
10_{16}	Data Link Capability Report	$\leq$4.0s (see Note 2)
11_{16}-16_{16}	Reserved for extension to datalink capability reports	5.0s
17_{16}	Common usage GICB Capability Report	5.0s
18_{16}-$1F_{16}$	Mode S Specific Services Capability Reports	5.0s
20_{16}	Aircraft Identification	5.0s
21_{16}	Aircraft and airline registration markings	15.0s
22_{16}	Antenna positions	15.0s
23_{16}	Reserved for antenna position	15.0s
24_{16}	Reserved for aircraft parameters	15.0s
25_{16}	Aircraft type	15.0s
26_{16}-$2F_{16}$	Unassigned	N/A
30_{16}	TCAS/ACAS Active Resolution Advisory	§2.2.22.1.2.1.3
31_{16}-$3F_{16}$	Unassigned	N/A
40_{16}	Selected vertical intention	1.0s
41_{16}	Next waypoint identifier	1.0s
42_{16}	Next waypoint position	1.0s
43_{16}	Next waypoint information	0.5s
44_{16}	Meteorological routine air report	1.0s
45_{16}	Meteorological hazard report	1.0s
46_{16}	Reserved for flight management system Mode 1	To be determined
47_{16}	Reserved for flight management system Mode 2	To be determined
48_{16}	VHF channel report	5.0s
49_{16}-$4F_{16}$	Unassigned	N/A
50_{16}	Track and turn report	1.3s
51_{16}	Position report coarse	1.3s
52_{16}	Position report fine	1.3s
53_{16}	Air-referenced state vector	1.3s
54_{16}	Waypoint 1	5.0s
55_{16}	Waypoint 2	5.0s
56_{16}	Waypoint 3	5.0s

Transponder register No.	*Assignment*	*Maximum update interval (see Note 1)*
57_{16}-$5E_{16}$	Unassigned	N/A
$5F_{16}$	Quasi-static parameter monitoring	0.5s
60_{16}	Heading and speed report	1.3s
61_{16}	Extended Squitter Emergency/Priority Status	1.0s
62_{16}	Reserved for Target State and Status Information	N/A
63_{16}	Reserved for Extended Squitter	N/A
64_{16}	Reserved for Extended Squitter	N/A
65_{16}	Extended Squitter Aircraft Operational Status	1.7 s
66_{16}-$6F_{16}$	Reserved for Extended Squitter	N/A
70_{16}-75_{16}	Reserved for future aircraft downlink parameters	N/A
76_{16}-$E0_{16}$	Unassigned	N/A
$E1_{16}$-$E2_{16}$	Reserved for Mode S BITE	N/A
$E3_{16}$	Transponder type/part number	15 s
$E4_{16}$	Transponder software revision number	15 s
$E5_{16}$	TCAS/ACAS unit part number	15 s
$E6_{16}$	TCAS/ACAS unit software revision number	15 s
$E7_{16}$-$F0_{16}$	Unassigned	N/A
$F1_{16}$	Military applications	15 s
$F2_{16}$	Military applications	15 s
$F3_{16}$-FF_{16}	Unassigned	N/A

Notes:

1. *The term "minimum update rate" is used in this document. The minimum update rate is obtained when data is loaded in one register field once every maximum update interval.*
2. *The data link capability report (Register 10_{16}) shall be updated within one second of the data changing and at least every four seconds thereafter.*

B.2.3 General Conventions on Data Formats

B.2.3.1 Validity of Data

The bit patterns contained in the 56-bit transponder registers (other than registers accessed by BDS Codes 0,2; 0,3; 0,4; 1,0; 1,7 to 1,C; 2,0 and 3,0) are considered as valid application data only if:

1) The Mode S Specific Services capability bit is set in Register 10_{16}. This is indicated by bit 25 being set to "ONE," and

2) The GICB service corresponding to the application is shown as "supported" by the corresponding bit in the GICB capability report Registers 17_{16} to $1C_{16}$ being set to "ONE," and

Notes:

1. *The intent of the capability bits in Register 17_{16} is to indicate that useful data are contained in the corresponding transponder Register. For this reason, each bit for a Register is cleared if data becomes unavailable (see ICAO Doc 9871, §A.2.5.4.1) and set again when data insertion into the register resumes.*

2. *A bit set in Registers 18_{16} to $1C_{16}$ indicates that the application using this register has been installed on the aircraft. These bits are not cleared to reflect the real-time loss of an application, as is done for Register 17_{16} (see ICAO Doc 9871, §A.2.5.4.2).*

3) The data value is valid at the time of extraction. This is indicated by a data field status bit (if specified for that field). When this status bit is set to "ONE" the data field(s) which follow, up to the next status bit, are valid. When this status bit is set to "ZERO", the data field(s) are invalid.

B.2.3.2 Representation of Numeric Data

Numerical data shall be represented as follows:

1) Numerical data are represented as binary numerals. When the value is signed, 2s complement representation shall be used, and the bit following the status bit are the sign bit.

2) Unless otherwise specified, whenever more bits of resolution are available from the data source than in the data field into which that data are to be loaded, the data are rounded to the nearest value that can be encoded in that data field.

Note: *Unless otherwise specified, it is accepted that the data source may have less bits of resolution than the data field.*

3) When the data source provides data with a higher or lower range than the data field, the data are truncated to the respective maximum or minimum value that can be encoded in the data field.

4) In all cases where a status bit is specified in the data field it shall be set to "ONE" to indicate VALID and to "ZERO" to indicate INVALID.

Notes:

1. *This facilitates partial loading of the registers.*
2. *VALID indicates that the data contained in the field, represents real operational information which can be used by the application. This facilitates partial loading of the registers.*
3. *As an example, where ARINC 429 data are used, the single status bit specified in the field is derived from ARINC 429 status bits 30 and 31 bits as follows:*
   a) *If bits 30 and 31 represent "Failure Warning, No Computed Data" then the status bit shall be set to "INVALID".*

b) *If bits 30 and 31 represent "Functional Test" then the status bit shall be set to "INVALID".*

c) *If bits 30 and 31 represent "Normal Operation," "plus sign," or "minus sign," then the status bit shall be set to "VALID" provided that the data are being updated at the required rate (§B.2.2).*

d) *If the data are not being updated at the required rate (§B.2.2), then the status bit shall be set to "INVALID".*

5) When specified in the field, the switch bit indicates which of two alternative data types is being used to update the parameter in the transponder register.

6) The bits in the MB field are numbered in the order of their transmission, beginning with bit 1. Unless otherwise stated, numerical values encoded by groups (fields) of bits are encoded using positive binary notation and the first bit transmitted is the most significant bit (MSB). Information will be coded in fields which consist of at least one bit.

7) Registers containing data intended for broadcast Comm-B have the broadcast identifier located in the eight most significant bits of the MB field.

Notes:

1. *When multiple data sources are available, the one with the highest resolution should be selected.*

2. *By default, values indicated in the range of the different fields of registers have been rounded to the nearest integer value or represented as a fraction.*

B.2.3.3 Representation of Alphanumeric Character Encoding

For registers requiring alphanumeric character encoding, each character shall be coded as a 6-bit subset of the International Alphabet Number 5 (IA-5) as illustrated in Table B-2-1. The character code shall be transmitted with the high order unit (b6) first and the reported character string shall be transmitted with its left-most character first. Characters shall be coded consecutively without intervening SPACE code. Any unused character spaces at the end of the subfield shall contain a SPACE character code.

Table B-2-1: 6-Bit Subset of International Alphabet Number (IA-5) for Character Coding

				b6	0	0	1	1
				b5	0	1	0	1
b4	b3	b2	b1					
E	0	0	0			P	SP	0
0	0	0	1		A	Q		1
0	0	1	0		B	R		2
0	0	1	1		C	S		3
0	1	0	0		D	T		4
0	1	0	1		E	U		5
0	1	1	0		F	V		6
0	1	1	1		G	W		7
1	0	0	0		H	X		8
1	0	0	1		I	Y		9
1	0	1	0		J	Z		
1	0	1	1		K			
1	1	0	0		L			
1	1	0	1		M			
1	1	1	0		N			
1	1	1	1		O			

SP – SPACE Code

B.3 BDS Register Formats

The definitions of the registers herein are in conformance with ICAO Document 9871, 1st Edition. Tables are numbered B-3-X where "X" is the decimal equivalent of the BDS code Y,Z where Y is the BDS1 code and Z is the BDS2 code, used to access the data format for a particular register. The following tables are not included in this section:

B-3-2 to B-3-4 (Used by the linked Comm-B protocol)
B-3-5 to B-3-6 (Reserved for extended squitter)
B-3-8 to B-3-12 (Reserved for extended squitter)
B-3-13 to B-3-14 (Reserved for air/air state information)
B-3-15 (Reserved for TCAS/ACAS)
B-3-17 to B-3-22
B-3-35 (Reserved for antenna position)
B-3-36 (Reserved for aircraft parameters)
B-3-38 to B-3-47
B-3-49 to B-3-63
B-3-68 to B-3-69 (Reserved for meteorological reports)
B-3-70 to B-3-71
B-3-73 to B-3-79
B-3-87 to B-3-94
B-3-99 to B-3-100 (Reserved for extended squitter)
B-3-102 to B-3-111 (Reserved for extended squitter)
B-3-112 to B-3-224

B-3-225 to B-3-226 (Reserved for Mode S BITE)
B-3-231 to B-3-240
B-3-243 to B-3-255

For the following ADS-B Registers, reference RTCA/DO-260A for definitions:

Table B-3-5	BDS Code 0,5	Extended Squitter Airborne Position
Table B-3-6	BDS Code 0,6	Extended Squitter Surface Position
Table B-3-7	BDS Code 0,7	Extended Squitter Status
Table B-3-8	BDS Code 0,8	Extended Squitter Aircraft Identification and Category
Table B-3-9a	BDS Code 0,9	Extended Squitter Airborne Velocity (Subtypes 1 and 2 – Velocity Over Ground)
Table B-3-9b	BDS Code 0,9	Extended Squitter Airborne Velocity (Subtypes 3 and 4 – Airspeed and Heading)
Table B-3-10	BDS Code 0,A	Extended Squitter Event-Driven Information
Table A-2-97	BDS Code 6,1	Extended Squitter Emergency/Priority Status
Table A-2-101	BDS Code 6,5	Extended Squitter Aircraft Operational Status

Table B-3-7: BDS Code 0,7 – Extended Squitter Status

MB FIELD

Bit		Field
1	MSB	TRANSMISSION RATE
2	LSB	SUBFIELD (TRS)
3		ALTITUDE TYPE SUBFIELD (ATS)
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		RESERVED
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		

PURPOSE: To provide information on the capability and status of the extended squitter rate of the transponder.

Transmission rate subfield (TRS) shall be coded as follows:

0 = No capability to determine surface squitter rate
1 = High surface squitter rate selected
2 = Low surface squitter rate selected
3 = Reserved

Altitude type subfield (ATS) shall be coded as follows:

0 = Barometric altitude
1 = GNSS height (HAE)

Aircraft determination of surface squitter rate:

For aircraft that have the capability to automatically determine their surface squitter rate, the method used to switch between the high and low transmission rates shall be as follows:

a) Switching from high to low rate: Aircraft shall switch from high to low rate when the on-board navigation unit reports that the aircraft's position has not changed more than 10 meters in any 30 second interval. The algorithm used to control the squitter rate shall save the aircraft's position at the time that low rate is selected.

b) Switching from low to high rate: Aircraft shall switch from low to high rate as soon as the aircraft's position has changed by 10 meters or more since the low rate was selected.

For transponder-based implementations, the automatically selected transmission rate shall be subject to being overridden by commands received form the ground control.

Table B-3-11: BDS Code 0,B – Air-to-Air State Information 1 (Aircraft State)

MB FIELD

1	STATUS
2	MSB = 1024 knots
3	
4	
5	TRUE AIR SPEED
6	
7	
8	Range [0, 2047] knots
9	
10	
11	
12	LSB = 1.0 knot
13	SWITCH (0 = Magnetic heading 1 = True heading)
14	STATUS
15	SIGN
16	MSB = 90 degrees
17	
18	HEADING
19	
20	
21	Range [-180, +180] degrees
22	
23	
24	LSB = 360/1024 degrees
25	STATUS
26	SIGN
27	MSB = 90 degrees
28	
29	
30	
31	TRUE TRACK ANGLE
32	
33	
34	
35	
36	Range [-180, +180] degrees
37	
38	
39	
40	LSB = 360/32768 degrees
41	STATUS
42	MSB = 1024 knots
43	
44	
45	
46	GROUND SPEED
47	
48	
49	
50	
51	Range [0, 2048] knots
52	
53	
54	
55	LSB = 1/8 knot
56	RESERVED

PURPOSE: To report threat aircraft state information in order to improve the ability of TCAS/ACAS to evaluate the threat and select a resolution maneuver.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.3.2.*

Table B-3-12: BDS Code 0,C – Air-to-Air State Information 2 (Aircraft Intent)

MB FIELD

Bit	Field
1	STATUS
2	MSB = 32768 feet
3	
4	
5	LEVEL OFF ALTITUDE
6	
7	
8	
9	Range [0, 65520] feet
10	
11	
12	
13	LSB = 16 feet
14	STATUS
15	SIGN
16	MSB = 90 degrees
17	
18	NEXT COURSE (TRUE GROUND TRACK)
19	
20	
21	Range [+180, -180] degrees
22	
23	
24	LSB = 360/1024 degrees
25	STATUS
26	MSB = 128 seconds
27	
28	TIME TO NEXT WAYPOINT
29	All ONEs = time exceeds 255 seconds
30	
31	
32	Range [0, 256] seconds
33	
34	LSB = 0.5 seconds
35	STATUS
36	SIGN
37	MSB = 8192 ft/min
38	
39	VERTICAL VELOCITY (UP IS POSITIVE)
40	
41	Range [-16384, +16320] ft/min
42	
43	
44	LSB = 64 ft/min
45	STATUS
46	SIGN
47	MSB = 45 degrees
48	
49	ROLL ANGLE
50	
51	Range [-90, 89] degrees
52	
53	LSB = 45/64 degrees
54	RESERVED
55	
56	

PURPOSE: To report threat aircraft state information in order to improve the ability of TCAS/ACAS to evaluate the threat and select a resolution maneuver.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.3.2.*

Table B-3-16: BDS Code 1,0 – Data Link Capability Report (§2.2.19.1.12.5)

MB FIELD

Bit	Field
1	MSB
2	
3	
4	BDS Code 1,0
5	
6	
7	
8	LSB
9	Continuation flag (see 9)
10	
11	
12	RESERVED
13	
14	
15	
16	Reserved for TCAS/ACAS (see 15)
17	
18	
19	
20	Mode-S subnetwork version number (see 12)
21	
22	
23	
24	Transponder enhanced protocol indicator (see 4)
25	Mode-S specific services capability (see 2)
26	
27	Uplink ELM average throughput capability (see 13)
28	
29	Downlink ELM: throughput capability of downlink ELM
30	Containing the maximum number of ELM segments that the
31	Transponder can deliver in response to a single requesting
32	Interrogation (UF = 24). (see 14)
33	Aircraft identification capability (see 11)
34	Squitter capability subfield (SCS) (see 5)
35	Surveillance identifier code (SIC) (see 6)
36	Common usage GICB capability report (see 7)
37	
38	RESERVED FOR TCAS/ACAS (see 16, 17 and 18)
39	
40	
41	MSB
42	
43	
44	
45	
46	
47	Bit array indicating the support status of DTE
48	subaddresses 0 to 15 (see 3 and 8)
49	
50	
51	
52	
53	
54	
55	
56	LSB

PURPOSE: To report the data link capability of the Mode S transponder/ data link installation.

The coding of this register shall conform to:

1) Annex 10 Volume IV, §3.1.2.6.10.2.

2) 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) Starting from the MSB, each subsequent bit position shall represent the DTE subaddress in the range from 0 to 15.

4) The enhanced protocol indicator shall denote a Level 5 transponder when set to 1, and a Level 2 to 4 transponder when set to 0.

5) The squitter capability subfield (SCS) shall be set to 1 if both registers 05_{16} and 06_{16} have been updated within the last ten, plus or minus one, seconds. Otherwise, it shall be set to 0.

   Note: *Registers 05_{16} and 06_{16} are used for the extended squitter Airborne and surface position reports, respectively.*

6) The surveillance identifier code (SIC) bit shall be interpreted as follows:

   0 = no surveillance identifier code capability
   1 = surveillance identifier code capability

7) 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 capability report changes, register 17_{16} shall be sampled at approximately one minute intervals to check for changes.

8) The current status of the on-board DTE shall be periodically reported to the GDLP by on-board sources. Since a change in this field results in a broadcast of the capability report, status inputs shall be sampled at approximately one minute intervals.

9) In order to determine the extent of any continuation of the data link capability report (into those registers reserved for this purpose: register 11_{16} to register 16_{16}), bit 9 shall be reserved as a continuation flag to indicate if the subsequent register shall be extracted. For example: upon detection of bit 9 = 1 in register 10_{16}, then register 11_{16} shall be extracted. If bit 9 = 1, in register 11_{16}, then register 12_{16} shall be extracted, and so on (up to register 16_{16}). Note that if bit 9 = 1 in register 16_{16}, then this shall be considered as an error condition.

(Requirements are continued on the next page)

Table B-3-16: BDS Code 1,0 – Data Link Capability Report (concluded)

10) The Mode-S transponder may update bits 1-8, 16, 33, 35 and 37-40 independent of the ADLP. These bits are provided by the transponder when the data link capability report is broadcast as a result of a transponder detected change in capability reported by the ADLP (§3.1.2 of Annex 10 Volume IV).

11) Bit 33 indicates the availability of Aircraft Identification data. It shall be set by the transponder if the data comes to the transponder through a separate interface and not through the ADLP.

12) The Mode-S subnetwork version number shall be coded as follows:

Version Number	Annex 10 amendment (Year and Edition)		RTCA	EUROCAE
0	Mode-S subnetwork not available			
1	1996	---		
2	1998	---		
3	2002	---		
4	2007	Doc 9871, Edition 1	DO-181D	ED-73C
5 - 127	Unassigned			

13) Uplink ELM average throughput capability shall be coded as follows:

0 = No UELM Capability
1 = 16 UELM segments in 1 second
2 = 16 UELM segments in 500 ms
3 = 16 UELM segments in 250 ms
4 = 16 UELM segments in 125 ms
5 = 16 UELM segments in 60 ms
6 = 16 UELM segments in 30 ms
7 = Unassigned

14) Downlink ELM throughput capability shall be coded as follows:

0 = No DELM Capability
1 = One 4 segment DELM every second
2 = One 8 segment DELM every second
3 = One 16 segment DELM every second
4 = One 16 segment DELM every 500 ms
5 = One 16 segment DELM every 250 ms
6 = One 16 segment DELM every 125 ms
7-15 = Unassigned

15) Bit 16 shall be set to 1 to indicate that the transponder TCAS interface is operational and the transponder is receiving TCAS RI=2, 3 or 4.

16) Bits 37 and 38 indicates the aircraft's on-board TCAS resolution advisory generation capability and shall be coded as follows:

Bit 37	Bit 38	Meaning
0	0	No on-board resolution advisory generation capability (TCAS RI not equal to 3 or 4, or no operational interface).
0	1	An on-board vertical-only resolution advisory generation capability exists (TCAS RI = 3)
1	0	An on-board vertical and horizontal resolution advisory generation capability exists (TCAS RI=4)
1	1	No assigned

17) Bit 39 set to 1 shall indicate that the transponder/TCAS system is compatible with RTCA/DO-185A.

18) Bit 40 is "Reserved" for future use by TCAS. Until appropriate coding of this bit has been defined, it should be set to 0 by the TCAS.

Table B-3-23: BDS Code 1,7 – Common Usage GICB Capability Report

MB FIELD

1	0,5 Extended Squitter Airborne Position
2	0,6 Extended Squitter Surface Position
3	0,7 Extended Squitter Status
4	0,8 Extended Squitter Type and Identification
5	0,9 Extended Squitter Airborne Velocity Information
6	0,A Extended Squitter Event-Driven Information
7	2,0 Aircraft identification
8	2,l Aircraft registration number
9	4,0 Selected vertical intention
10	4,l Next waypoint identifier
11	4,2 Next waypoint position
12	4,3 Next waypoint information
13	4,4 Meteorological routine report
14	4,5 Meteorological hazard report
15	4.8 VHF channel report
16	5,0 Track and turn report
17	5,1 Position coarse
18	5,2 Position fine
19	5,3 Air-referenced state vector
20	5,4 Waypoint 1
21	5,5 Waypoint 2
22	5,6 Waypoint 3
23	5,F Quasi-static parameter monitoring
24	6,0 Heading and speed report
25	Reserved for aircraft capability
26	Reserved for aircraft capability
27	E,1 Reserved for Mode S BITE (Built In Test Equipment)
28	E,2 Reserved for Mode S BITE (Built In Test Equipment)
29	F,1 Military applications
30–56	RESERVED

PURPOSE: To indicate common usage GICB services currently Supported.

1) Each bit position shall indicate that the associated register is available in the aircraft installation when set to 1.

2) All registers shall be constantly monitored at a rate consistent with their individual required update rate and the corresponding capability bit shall be set to 1 only when valid data is being input to that register at the required rate or above.

3) The capability bit shall be set to a 1 if at least one field in the register is receiving valid data at the required rate with the status bits for all fields not receiving valid data at the required rate set to ZERO (0).

4) Registers 18_{16} to $1C_{16}$ shall be independent of register 17_{16}.

Table B-3-24: BDS Code 1,8 – MSSS GICB Capability Report (1 of 5)

MB FIELD

1	BDS 3,8
2	BDS 3,7
3	BDS 3,6
4	BDS 3,5
5	BDS 3,4
6	BDS 3,3
7	BDS 3,2
8	BDS 3,1
9	BDS 3,0
10	BDS 2,F
11	BDS 2,E
12	BDS 2,D
13	BDS 2,C
14	BDS 2,B
15	BDS 2,A
16	BDS 2,9
17	BDS 2,8
18	BDS 2,7
19	BDS 2,6
20	BDS 2,5
21	BDS 2,4
22	BDS 2,3
23	BDS 2,2
24	BDS 2,1
25	BDS 2,0
26	BDS 1,F
27	BDS 1,E
28	BDS 1,D
29	BDS 1,C
30	BDS 1,B
31	BDS 1,A
32	BDS 1,9
33	BDS 1,8
34	BDS 1,7
35	BDS 1,6
36	BDS 1,5
37	BDS 1,4
38	BDS 1,3
39	BDS 1,2
40	BDS 1,1
41	BDS 1,0
42	BDS 0,F
43	BDS 0,E
44	BDS 0,D
45	BDS 0,C
46	BDS 0,B
47	BDS 0,A
48	BDS 0,9
49	BDS 0,8
50	BDS 0,7
51	BDS 0,6
52	BDS 0,5
53	BDS 0,4
54	BDS 0,3
55	BDS 0,2
56	BDS 0,1

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to 1.

Starting from the LSB, each bit position shall represent the register number, in accordance with the following table:

BDS Code	**Capability installed for register**
BDS 1,8	01_{16} to 38_{16}
BDS 1,9	39_{16} to 70_{16}
BDS 1,A	71_{16} to $A8_{16}$
BDS 1,B	$A9_{16}$ to $E0_{16}$
BDS 1,C	$E1_{16}$ to FF_{16}

The 25 most significant bits of Register $1C_{16}$ shall not be used.

Table B-3-25: BDS Code 1,9 – MSSS GICB Capability Report (2 of 5)

MB FIELD

1	BDS 7,0
2	BDS 6,F
3	BDS 6,E
4	BDS 6,D
5	BDS 6,C
6	BDS 6,B
7	BDS 6,A
8	BDS 6,9
9	BDS 6,8
10	BDS 6,7
11	BDS 6,6
12	BDS 6,5
13	BDS 6,4
14	BDS 6,3
15	BDS 6,2
16	BDS 6,1
17	BDS 6,0
18	BDS 5,F
19	BDS 5,E
20	BDS 5,D
21	BDS 5,C
22	BDS 5,B
23	BDS 5,A
24	BDS 5,9
25	BDS 5,8
26	BDS 5,7
27	BDS 5,6
28	BDS 5,5
29	BDS 5,4
30	BDS 5,3
31	BDS 5,2
32	BDS 5,1
33	BDS 5,0
34	BDS 4,F
35	BDS 4,E
36	BDS 4,D
37	BDS 4,C
38	BDS 4,B
39	BDS 4,A
40	BDS 4,9
41	BDS 4,8
42	BDS 4,7
43	BDS 4,6
44	BDS 4,5
45	BDS 4,4
46	BDS 4,3
47	BDS 4,2
48	BDS 4,1
49	BDS 4,0
50	BDS 3,F
51	BDS 3,E
52	BDS 3,D
53	BDS 3,C
54	BDS 3,B
55	BDS 3,A
56	BDS 3,9

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to 1.

Table B-3-26: BDS Code 1,A – MSSS GICB Capability Report (3 of 5)

MB FIELD

1	BDS A,8
2	BDS A,7
3	BDS A,6
4	BDS A,5
5	BDS A,4
6	BDS A,3
7	BDS A,2
8	BDS A,1
9	BDS A,0
10	BDS 9,F
11	BDS 9,E
12	BDS 9,D
13	BDS 9,C
14	BDS 9,B
15	BDS 9,A
16	BDS 9,9
17	BDS 9,8
18	BDS 9,7
19	BDS 9,6
20	BDS 9.5
21	BDS 9,4
22	BDS 9,3
23	BDS 9,2
24	BDS 9,1
25	BDS 9,0
26	BDS 8,F
27	BDS 8,E
28	BDS 8,D
29	BDS 8,C
30	BDS 8,B
31	BDS 8,A
32	BDS 8,9
33	BDS 8,8
34	BDS 8,7
35	BDS 8,6
36	BDS 8,5
37	BDS 8,4
38	BDS 8,3
39	BDS 8,2
40	BDS 8,1
41	BDS 8,0
42	BDS 7,F
43	BDS 7,E
44	BDS 7,D
45	BDS 7,C
46	BDS 7,B
47	BDS 7,A
48	BDS 7,9
49	BDS 7,8
50	BDS 7,7
51	BDS 7,6
52	BDS 7,5
53	BDS 7,4
54	BDS 7,3
55	BDS 7,2
56	BDS 7,1

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to 1.

Table B-3-27: BDS Code 1,B – MSSS GICB Capability Report (4 of 5)

MB FIELD

1	BDS E,0
2	BDS D,F
3	BDS D,E
4	BDS D,D
5	BDS D,C
6	BDS D,B
7	BDS D,A
8	BDS D,9
9	BDS D,8
10	BDS D,7
11	BDS D,6
12	BDS D,5
13	BDS D,4
14	BDS D,3
15	BDS D,2
16	BDS D,1
17	BDS D,0
18	BDS C,F
19	BDS C,E
20	BDS C,D
21	BDS C,C
22	BDS C,B
23	BDS C,A
24	BDS C,9
25	BDS C,8
26	BDS C,7
27	BDS C,6
28	BDS C,5
29	BDS C,4
30	BDS C,3
31	BDS C,2
32	BDS C,1
33	BDS C,0
34	BDS B,F
35	BDS B,E
36	BDS B,D
37	BDS B,C
38	BDS B,B
39	BDS B,A
40	BDS B,9
41	BDS B,8
42	BDS B,7
43	BDS B,6
44	BDS B,5
45	BDS B,4
46	BDS B.3
47	BDS B,2
48	BDS B,1
49	BDS B,0
50	BDS A,F
51	BDS A,E
52	BDS A,D
53	BDS A,C
54	BDS A,B
55	BDS A,A
56	BDS A,9

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to 1.

Table B-3-28: BDS Code 1,C – MSSS GICB Capability Report (5 of 5)

MB FIELD

1	RESERVED
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	BDS F,F
27	BDS F,E
28	BDS F,D
29	BDS F,C
30	BDS F,B
31	BDS F,A
32	BDS F,9
33	BDS F,8
34	BDS F,7
35	BDS F,6
36	BDS F,5
37	BDS F,4
38	BDS F,3
39	BDS F,2
40	BDS F,1
41	BDS F,0
42	BDS E,F
43	BDS E,E
44	BDS E,D
45	BDS E,C
46	BDS E,B
47	BDS E,A
48	BDS E,9
49	BDS E,8
50	BDS E,7
51	BDS E,6
52	BDS E,5
53	BDS E,4
54	BDS E,3
55	BDS E,2
56	BDS E,1

PURPOSE: To indicate GICB services that are installed.

Each bit position shall indicate that the GICB service that it represents has been implemented in the aircraft installation when set to 1.

Table B-3-29: **BDS Code 1,D – MSSS MSP Capability Report (1 of 3)**

MB FIELD

1	Uplink MSP Channel 1
2	Uplink MSP Channel 2
3	Uplink MSP Channel 3
4	Uplink MSP Channel 4
5	Uplink MSP Channel 5
6	Uplink MSP Channel 6
7	Uplink MSP Channel 7
8	Uplink MSP Channel 8
9	Uplink MSP Channel 9
10	Uplink MSP Channel 10
11	Uplink MSP Channel 11
12	Uplink MSP Channel 12
13	Uplink MSP Channel 13
14	Uplink MSP Channel 14
15	Uplink MSP Channel 15
16	Uplink MSP Channel 16
17	Uplink MSP Channel 17
18	Uplink MSP Channel 18
19	Uplink MSP Channel 19
20	Uplink MSP Channel 20
21	Uplink MSP Channel 21
22	Uplink MSP Channel 22
23	Uplink MSP Channel 23
24	Uplink MSP Channel 24
25	Uplink MSP Channel 25
26	Uplink MSP Channel 26
27	Uplink MSP Channel 27
28	Uplink MSP Channel 28
29	Downlink MSP Channel 1
30	Downlink MSP Channel 2
31	Downlink MSP Channel 3
32	Downlink MSP Channel 4
33	Downlink MSP Channel 5
34	Downlink MSP Channel 6
35	Downlink MSP Channel 7
36	Downlink MSP Channel 8
37	Downlink MSP Channel 9
38	Downlink MSP Channel 10
39	Downlink MSP Channel 11
40	Downlink MSP Channel 12
41	Downlink MSP Channel 13
42	Downlink MSP Channel 14
43	Downlink MSP Channel 15
44	Downlink MSP Channel 16
45	Downlink MSP Channel 17
46	Downlink MSP Channel 18
47	Downlink MSP Channel 19
48	Downlink MSP Channel 20
49	Downlink MSP Channel 21
50	Downlink MSP Channel 22
51	Downlink MSP Channel 23
52	Downlink MSP Channel 24
53	Downlink MSP Channel 25
54	Downlink MSP Channel 26
55	Downlink MSP Channel 27
56	Downlink MSP Channel 28

PURPOSE: To indicate MSP services that are installed and require a service.

Each bit shall indicate that the MSP it represents requires service when set to 1.

1) The conditions for setting the capability bits shall be as defined in the specification of the corresponding service.

Table B-3-30: **BDS Code 1,E – MSSS MSP Capability Report (2 of 3)**

MB FIELD

1	Uplink MSP Channel 29
2	Uplink MSP Channel 30
3	Uplink MSP Channel 31
4	Uplink MSP Channel 32
5	Uplink MSP Channel 33
6	Uplink MSP Channel 34
7	Uplink MSP Channel 35
8	Uplink MSP Channel 36
9	Uplink MSP Channel 37
10	Uplink MSP Channel 38
11	Uplink MSP Channel 39
12	Uplink MSP Channel 40
13	Uplink MSP Channel 41
14	Uplink MSP Channel 42
15	Uplink MSP Channel 43
16	Uplink MSP Channel 44
17	Uplink MSP Channel 45
18	Uplink MSP Channel 46
19	Uplink MSP Channel 47
20	Uplink MSP Channel 48
21	Uplink MSP Channel 49
22	Uplink MSP Channel 50
23	Uplink MSP Channel 51
24	Uplink MSP Channel 52
25	Uplink MSP Channel 53
26	Uplink MSP Channel 54
27	Uplink MSP Channel 55
28	Uplink MSP Channel 56
29	Downlink MSP Channel 29
30	Downlink MSP Channel 30
31	Downlink MSP Channel 31
32	Downlink MSP Channel 32
33	Downlink MSP Channel 33
34	Downlink MSP Channel 34
35	Downlink MSP Channel 35
36	Downlink MSP Channel 36
37	Downlink MSP Channel 37
38	Downlink MSP Channel 38
39	Downlink MSP Channel 39
40	Downlink MSP Channel 40
41	Downlink MSP Channel 41
42	Downlink MSP Channel 42
43	Downlink MSP Channel 43
44	Downlink MSP Channel 44
45	Downlink MSP Channel 45
46	Downlink MSP Channel 46
47	Downlink MSP Channel 47
48	Downlink MSP Channel 48
49	Downlink MSP Channel 49
50	Downlink MSP Channel 50
51	Downlink MSP Channel 51
52	Downlink MSP Channel 52
53	Downlink MSP Channel 53
54	Downlink MSP Channel 54
55	Downlink MSP Channel 55
56	Downlink MSP Channel 56

PURPOSE: To indicate MSP services that are installed and require a service.

Each bit shall indicate that the MSP it represents requires service when set to 1.

1) The conditions for setting the capability bits shall be as defined in the specification of the corresponding service.

Table B-3-31: BDS Code 1,F – MSSS MSP Capability Report (3 of 3)

MB FIELD

Bit	Field
1	Uplink MSP Channel 57
2	Uplink MSP Channel 58
3	Uplink MSP Channel 59
4	Uplink MSP Channel 60
5	Uplink MSP Channel 61
6	Uplink MSP Channel 62
7	Uplink MSP Channel 63
8–28	RESERVED
29	Downlink MSP Channel 57
30	Downlink MSP Channel 58
31	Downlink MSP Channel 59
32	Downlink MSP Channel 60
33	Downlink MSP Channel 61
34	Downlink MSP Channel 62
35	Downlink MSP Channel 63
36–56	RESERVED

PURPOSE: To indicate MSP services that are installed and require a service.

Each bit shall indicate that the MSP it represents requires service when set to 1.

1) The conditions for setting the capability bits shall be as defined in the specification of the corresponding service.

Table B-3-32: BDS Code 2,0 – Aircraft Identification (§2.2.19.1.13)

MB FIELD

1	MSB	
2		
3		
4		BDS Code 2,0
5		
6		
7		
8	LSB	
9	MSB	
10		
11		CHARACTER 1
12		
13		
14	LSB	
15	MSB	
16		
17		CHARACTER 2
18		
19		
20	LSB	
21	MSB	
22		
23		CHARACTER 3
24		
25		
26	LSB	
27	MSB	
28		
29		
30		CHARACTER 4
31		
32	LSB	
33	MSB	
34		
35		
36		CHARACTER 5
37		
38	LSB	
39	MSB	
40		
41		
42		CHARACTER 6
43		
44	LSB	
45	MSB	
46		
47		
48		CHARACTER 7
49		
50	LSB	
51	MSB	
52		
53		
54		CHARACTER 8
55		
56	LSB	

PURPOSE: To report aircraft identification to the ground.

1) Annex 10, Volume IV, §3.1.2.9.

2) The character coding to be used shall be identical to that defined in Table B-2-1.

3) This data may be input to the transponder from sources other than the Mode-S ADLP.

4) Characters 1 – 8 of this format shall be used by the Extended Squitter application.

5) Capability to support this register shall be indicated by setting bit 33 in register 10_{16} and the relevant bits in registers 17_{16} and 18_{16}.

6) The aircraft identification shall be that employed in the flight plan. When no flight plan is available, the registration marking of the aircraft shall be used.

Note: *Additional implementation guidelines are provided in §B.4.1 of this Appendix.*

Table B-3-33: BDS Code 2,1 –Aircraft and Airline Registration Markings

MB FIELD

1	STATUS	
2	MSB	
3		
4	CHARACTER 1	
5		
6		
7	LSB	
8	MSB	
9		
10	CHARACTER 2	
11		
12		
13	LSB	
14	MSB	
15		
16	CHARACTER 3	
17		
18		
19	LSB	
20	MSB	
21		
22	CHARACTER 4	AIRCRAFT
23		REGISTRATION
24		NUMBER
25	LSB	
26	MSB	
27		
28	CHARACTER 5	
29		
30		
31	LSB	
32	MSB	
33		
34	CHARACTER 6	
35		
36		
37	LSB	
38	MSB	
39		
40	CHARACTER 7	
41		
42		
43	LSB	
44	STATUS	
45	MSB	
46		
47	CHARACTER 1	
48		
49		
50	LSB	ICAO AIRLINE
51	MSB	REGISTRATION
52		MARKING
53	CHARACTER 2	
54		
55		
56	LSB	

PURPOSE: To permit ground systems to identify the aircraft without the necessity of compiling and maintaining continuously updated data banks.

The character coding shall be as defined in Table B-2-1.

Table B-3-34: BDS Code 2,2 –Antenna Positions

MB FIELD

Bit	Field	Antenna
1	MSB	
2	ANTENNA TYPE	
3	LSB	
4	MSB = 32 meters	
5		
6	X POSITION	
7	Range = [1, 63]	ANTENNA 1
8		
9	LSB = 1 meter	
10	MSB = 16 meters	
11		
12	Z POSITION	
13	Range = [1, 31]	
14	LSB = 1 meter	
15	MSB	
16	ANTENNA TYPE	
17	LSB	
18	MSB = 32 meters	
19		
20	X POSITION	
21	Range = [1, 63]	ANTENNA 2
22		
23	LSB = 1 meter	
24	MSB = 16 meters	
25		
26	Z POSITION	
27	Range = [1, 31]	
28	LSB = 1 meter	
29	MSB	
30	ANTENNA TYPE	
31	LSB	
32	MSB = 32 meters	
33		
34	X POSITION	
35	Range = [1, 63]	ANTENNA 3
36		
37	LSB = 1 meter	
38	MSB = 16 meters	
39		
40	Z POSITION	
41	Range = [1, 31]	
42	LSB = 1 meter	
43	MSB	
44	ANTENNA TYPE	
45	LSB	
46	MSB = 32 meters	
47		
48	X POSITION	
49	Range = [1, 63]	ANTENNA 4
50		
51	LSB = 1 meter	
52	MSB = 16 meters	
53		
54	Z POSITION	
55	Range = [1, 31]	
56	LSB = 1 meter	

PURPOSE: To provide information on the position of Mode-S and GNSS antennas on the aircraft in order to make very accurate Measurements of aircraft position possible.

1) The antenna type field shall be interpreted as follows:

   0 = Invalid
   1 = Mode-S bottom antenna
   2 = Mode-S top antenna
   3 = GNSS antenna
   4 to 7 = Reserved

2) The X position field shall be the distance in meters along the aircraft center line measured from the nose of the aircraft. The field shall be interpreted as invalid if the value is ZERO (0) and the value of 63 shall mean that the antenna position is 63 meters or more from the nose.

3) The Z position field shall be the distance in meters of the antenna from the ground, measured with the aircraft unloaded and on the ground. The field shall be interpreted as invalid if the value is ZERO (0), and the value of 31 shall mean that the antenna position is 31 meters or more from the ground.

Table B-3-37: BDS Code 2,5 –Aircraft Type

MB FIELD

1	MSB	
2		
3	AIRCRAFT TYPE	
4		
5		
6	LSB	
7	MSB	
8	NUMBER OF ENGINES	
9	LSB	
10	MSB	
11		
12	ENGINE TYPE	
13		
14		
15	LSB	
16	MSB	
17		
18	CHARACTER 1	
19		
20		
21	LSB	
22	MSB	
23		
24	CHARACTER 2	
25		
26		
27	LSB	
28	MSB	
29		
30	CHARACTER 3	MODEL
31		DESIGNATION
32		
33	LSB	
34	MSB	
35		
36	CHARACTER 4	
37		
38		
39	LSB	
40	MSB	
41		
42	CHARACTER 5	
43		
44		
45	LSB	
46	MSB	
47		
48	WAKE TURBULENCE	
49	CATEGORY	
50		
51	LSB	
52		
53		
54	RESERVED	
55		
56		

PURPOSE: To provide information on aircraft type.

1) Subfield coding

The coding shall be as in ICAO Doc 8643 – *Aircraft Type Designators*. All the subfields that contain characters shall be encoded using the 6-bit subset of IA-5 as specified in Table B-2-1.

2) Model designation

Coding shall consist of four characters as specified in ICAO Doc 8643. The fifth character shall be reserved for future expansion and shall contain all ZEROs until it is specified. 2222 in the first four characters shall mean that the designator is not specified.

3) Number of engines

This subfield shall be encoded as a binary number where number 7 means 7 or more engines.

Table B-3-48: BDS Code 3,0 – TCAS/ACAS Active Resolution Advisory

MB FIELD

Bit	Field
1	MSB
2	
3	
4	BDS Code 3,0
5	
6	
7	
8	LSB
9	MSB
10	
11	
12	
13	
14	
15	ACTIVE RESOLUTION ADVISORIES
16	
17	
18	
19	
20	
21	
22	LSB
23	MSB
24	RACs RECORD
25	
26	LSB
27	RA TERMINATED
28	MULTIPLE THREAT ENCOUNTER
29	MSB THREAT-TYPE INDICATOR
30	LSB
31	MSB
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	
43	THREAT IDENTITY DATA
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	LSB

PURPOSE: To report resolution advisories (RAs) generated by TCAS/ACAS equipment.

The coding of this register shall conform to:

1) See §2.2.22.1.2.1.3.

2) Bit 27 shall mean RA terminated when set to 1.

Table B-3-64: BDS Code 4,0 – Selected Vertical Intention

MB FIELD

Bit	Field	
1	STATUS	
2	MSB = 32768 feet	
3		
4		
5	MCP/FCU SELECTED ALTITUDE	
6		
7	Range = [0, 65520] feet	
8		
9		
10		
11		
12		
13	LSB = 16 feet	
14	STATUS	
15	MSB = 32768 feet	
16		
17		
18	FMS SELECTED ALTITUDE	
19		
20	Range = [0, 65520] feet	
21		
22		
23		
24		
25		
26	LSB = 16 feet	
27	STATUS	
28	MSB = 204.8 mb	
29		
30		
31		
32	BAROMETRIC PRESSURE SETTING	
33	MINUS 800 mb	
34		
35	Range = [0, 410] mb	
36		
37		
38		
39	LSB = 0.1 mb	
40		
41		
42		
43		
44	RESERVED	
45		
46		
47		
48	STATUS OF MCP/FCU MODE BITS	
49	VNAV MODE	MCP/FCU Mode bits
50	ALT HOLD MODE	
51	APPROACH MODE	
52	RESERVED	
53		
54	STATUS OF TARGET ALT SOURCE BITS	
55	MSB	TARGET ALT SOURCE
56	LSB	

PURPOSE: To provide ready access to information about the aircraft'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 de 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 1209.5 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 already 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

Note: *Additional implementation guidelines are provided in §B.4.2 of this Appendix.*

Table B-3-65: BDS Code 4,1 – Next Waypoint Details

MB FIELD

1	STATUS	
2	MSB	
3		
4		CHARACTER 1
5		
6		
7	LSB	
8	MSB	
9		
10		CHARACTER 2
11		
12		
13	LSB	
14	MSB	
15		
16		CHARACTER 3
17		
18		
19	LSB	
20	MSB	
21		
22		CHARACTER 4
23		
24		
25	LSB	
26	MSB	
27		
28		CHARACTER 5
29		
30		
31	LSB	
32	MSB	
33		
34		CHARACTER 6
35		
36		
37	LSB	
38	MSB	
39		
40		CHARACTER 7
41		
42		
43	LSB	
44	MSB	
45		
46		CHARACTER 8
47		
48		
49	LSB	
50	MSB	
51		
52		CHARACTER 9
53		
54		
55	LSB	
56		RESERVED

PURPOSE: To provide ready access to details about the next waypoint on an aircraft's route, without the need to establish a data link dialogue with the flight management system. This will assist with short and medium term tactical control.

1) Each character shall be encoded as specified in Table B-2-1.

Table B-3-66: BDS Code 4,2 – Next Waypoint Details

MB FIELD

1	STATUS
2	SIGN
3	MSB = 90 degrees
4	
5	
6	
7	
8	
9	WAYPOINT LATITUDE
10	
11	Range = [-180, +180] degrees
12	
13	
14	
15	
16	
17	
18	
19	
20	LSB = 90/131072 degrees
21	STATUS
22	SIGN
23	MSB = 90 degrees
24	
25	
26	
27	
28	
29	
30	WAYPOINT LONGITUDE
31	
32	Range = [-180, +180] degrees
33	
34	
35	
36	
37	
38	
39	
40	LSB = 90/131072 degrees
41	STATUS
42	SIGN
43	MSB = 65536 feet
44	
45	
46	
47	WAYPOINT CROSSING
48	ALTITUDE
49	
50	Range = [-131072, +131064] feet
51	
52	
53	
54	
55	
56	LSB = 8 feet

PURPOSE: To provide ready access to details about the next waypoint on an aircraft's route, without the need to establish a data link dialogue with the flight management system. This will assist with short and medium term tactical control.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.3.2.*

Table B-3-67: BDS Code 4,3 – Next Waypoint Details

MB FIELD

1	STATUS
2	SIGN
3	MSB = 90 degrees
4	
5	
6	BEARING TO WAYPOINT
7	
8	Range = [-180, +180] degrees
9	
10	
11	
12	LSB = 360/2048 degrees
13	STATUS
14	MSB = 204.8 minutes
15	
16	
17	
18	TIME TO GO
19	
20	Range = [0, 410] minutes
21	
22	
23	
24	
25	LSB = 0.1 minutes
26	STATUS
27	MSB = 3276.8 NM
28	
29	
30	
31	
32	
33	DISTANCE TO GO
34	
35	Range = [0, 6554] NM
36	
37	
38	
39	
40	
41	
42	LSB = 0.1 NM
43	
44	
45	
46	
47	
48	
49	
50	RESERVED
51	
52	
53	
54	
55	
56	

PURPOSE: To provide ready access to details about the next waypoint on an aircraft's route, without the need to establish a data link dialogue with the flight management system. This will assist with short and medium term tactical control.

1) The bearing to waypoint is the bearing from the current aircraft heading position to the waypoint position referenced to true north.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.3.2.*

Table B-3-72: BDS Code 4,8 – VHF Channel Report

MB FIELD

Bit		
1	MSB	
2		
3		
4		
5		
6		
7		
8		VHF 1
9		
10		
11		
12		
13		
14		
15	LSB	
16	STATUS	
17	MSB	VHF 1
18	LSB	AUDIO STATUS
19	MSB	
20		
21		
22		
23		
24		
25		
26		VHF 2
27		
28		
29		
30		
31		
32		
33	LSB	
34	STATUS	
35	MSB	VHF 2
36	LSB	AUDIO STATUS
37	MSB	
38		
39		
40		
41		
42		
43		VHF 3
44		
45		
46		
47		
48		
49		
50		
51	LSB	
52	STATUS	
53	MSB	VHF 3
54	LSB	AUDIO STATUS
55	MSB	121.5 MHz
56	LSB	AUDIO STATUS

PURPOSE: To allow the ATC system to monitor the settings of the VHF communications channel and to determine the manner in which each channel is being monitored by the aircrew.

Channel report coding:
Each VHF communications channel shall be determined form the 15-bit positive binary number, N in kHz, according to the formula:

Channel (MHz) = Base + N x 0.001 (MHz)

where: Base = 118.000 MHz

Notes:

1) *The use of binary to define the channel improves the coding efficiency.*
2) *This coding is compatible with analogue channels on 25 kHz, 8.33 kHz channel spacing and VDL as described below.*
3) *VDL has a full four bits allocated such that the active status of each of its four multiplex channels can be ascertained.*

25 kHz Bit	**VDL: Mode 3**	**Analogue**
16	Status	Status
15 (LSB)	MSB (12800 kHz)	MSB (12800 kHz)
	Range 118.000 to 143.575 136.975 (military use)	Range 118.000 to 143.575 136.975 (military use)
6	LSB (25 kHz)	LSB (25 kHz)
5		Unused
4	4 x channel active flags	Unused
3		Unused
2		8.33 indicator = 0
1 (MSB)	VDL indicator = 1	VDL indicator = 0

8.33 kHz Bit	**Analogue**
16	Status
15 (LSB)	MSB (17066 kHz)
...	Range 118.000 to 152.112 136.975 (military use)
4	LSB (17066/2048 kHz)
3	Unused
2	8.33 indicator = 1
1 (MSB)	VDL indicator = 0

Audio status coding:
Each pair of audio status bits shall be used to describe the aircrew Monitoring of that audio channel according to the following table:

Bit 1 (MSB)	Bit 2 (LSB)	
0	0	UNKNOWN
0	1	NOBODY
1	0	HEADPHONES ONLY
1	1	LOUDSPEAKER

Table B-3-80: 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 = -45 degrees)
14	MSB = 90 degrees
15	
16	
17	TRUE TRACK ANGLE
18	
19	Range = [-180, +180] degrees
20	
21	
22	
23	LSB = 90/512 degrees
24	STATUS
25	MSB = 1024 knots
26	
27	
28	GROUND SPEED
29	
30	Range = [0, 2046] knots
31	
32	
33	
34	LSB = 1024/512 knots
35	STATUS
36	SIGN 1 = Minus
37	MSB = 8 degrees/second
38	
39	
40	TRACK ANGLE RATE
41	Range = [-16, +16] degrees/second
42	
43	
44	
45	LSB = 8/256 degrees/second
46	STATUS
47	MSB = 1024 knots
48	
49	
50	TRUE AIRSPEED
51	
52	Range = [0, 2046] knots
53	
54	
55	
56	LSB = 2 knots

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

1) If the value of the 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 1: *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 GFM.

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

Note 2: *Two's complement coding is used for all signed fields as specified in §B.2.3.2.*

Note 3: *Additional implementation guidelines are provided in §B.4.3 of this Appendix.*

Table B-3-81: BDS Code 5,1 – Position Report Coarse

MB FIELD

1	STATUS
2	SIGN
3	MSB = 90 degrees
4	
5	
6	
7	
8	
9	LATITUDE
10	
11	Range = [-180, +180] degrees
12	(see 2)
13	
14	
15	
16	
17	
18	
19	
20	
21	LSB = 360/1048576 degrees
22	SIGN
23	MSB = 90 degrees
24	
25	
26	
27	
28	LONGITUDE
29	
30	Range = [-180, +180] degrees
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	LSB = 360/1048576 degrees
42	SIGN
43	MSB = 65536 feet
44	
45	
46	
47	PRESSURE
48	ALTITUDE
49	
50	Range = [-1000, +126752] feet
51	
52	
53	
54	
55	
56	LSB = 8 feet

PURPOSE: To provide a three-dimensional report of aircraft position.

1) The single status bit (bit 1) shall be set to ZERO (0) if any of the three parameters is invalid. This bit shall be identical to the status bit in register 52_{16}.

2) The required valid range for latitude is +90 degrees to -90 degrees, but the parameter shall be coded with an MSB of 90 degrees to allow the use of the same coding algorithm as for longitude.

3) The source of the information in this register shall be the same as that indicated in the FOM/SOURCE field of register 52_{16}.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.3.2.*

Table B-3-82: BDS Code 5,2 – Position Report Fine

MB FIELD

Bit	Field
1	STATUS (see 1)
2	MSB
3	FOM/SOURCE
4	
5	LSB
6	MSB = 90/128 degrees
7	
8	
9	
10	
11	
12	
13	LATITUDE FINE
14	
15	Range = [0, 180/128] degrees
16	
17	
18	
19	
20	
21	
22	
23	LSB = 90/16777216 degrees
24	MSB = 90/128 degrees
25	
26	
27	
28	
29	
30	
31	LONGITUDE FINE
32	
33	Range = [0, 180/128] degrees
34	
35	
36	
37	
38	
39	
40	
41	LSB = 90/16777216 degrees
42	SIGN
43	MSB = 65536 feet
44	
45	
46	
47	PRESSURE ALTITUDE
48	OR
49	GNSS HEIGHT (HAE)
50	
51	Range = [-1000, +126752] feet
52	
53	
54	
55	
56	LSB = 8 feet

PURPOSE: To provide a high-precision three-dimensional report on aircraft position when used in conjunction with register 51_{16}. information on the source of the data is included.

FOM/SOURCE Coding:
The decimal value of the binary-coded (Figure of Merit) FOM / SOURCE parameter shall be interpreted as follows:

0 = FOM > 10 NM or Unknown Accuracy
1 = FOM 10 NM/18.5 km (e.g., INS data) pressure altitude
2 = FOM 4 NM/7.4 km (e.g., VOR/DME) pressure altitude
3 = FOM 2 NM/3.7 km (e.g., DME/DME or GNSS) pressure altitude
4 = FOM 1 NM/1.85 km (e.g., DME/DME or GNSS) pressure altitude
5 = FOM 0.5 NM/926 m (e.g., DME/DME or GNSS) pressure altitude
6 = FOM 0.3 NM/556 m (e.g., DME/DME or GNSS) pressure altitude
7 = FOM 0.1 NM/185.2 m (ILS, MLS or differential GNSS) pressure altitude
8 = FOM 0.05 NM/92.6 m (ILS, MLS or differential GNSS) pressure altitude
9 = FOM 30 m (ILS, MLS or differential GNSS) pressure altitude
10 = FOM 10 m (ILS, MLS or differential GNSS) pressure altitude
11 = FOM 3 m (ILS, MLS or differential GNSS) pressure altitude
12 = FOM 30 m (ILS, MLS or differential GNSS) GNSS height
13 = FOM 10 m (ILS, MLS or differential GNSS) GNSS height
14 = FOM 3 m (ILS, MLS or differential GNSS) GNSS height
15 = Reserved

Note 1: *When GNSS is the source, then the FOM is encoded by the HFOM parameter. When RNP FMS is the source, the FOM is encoded by the ANP.*

1) The single status bit (bit 1) shall be set to ZERO (0) if any of the three parameters are invalid and is identical to the status bit in register 51_{16}.

2) The LATITUDE (fine) and LONGITUDE (fine) parameters are in 2's complement coding so they shall be interpreted in conjunction with the corresponding parameters in register 51_{16}.

3) When GNSS height is contained in bits 42 to 56, the pressure altitude can be obtained from register 51_{16}.

Note 2: *Two's complement coding is used for all signed fields as specified in §B.2.3.2.*

Note 3: *The Figure of Merit selected is the smallest number that encompasses the HFOM or the ANP.*

Table B-3-83: BDS Code 5,3 – Air-Referenced State Vector

MB FIELD

1	STATUS
2	SIGN
3	MSB = 90 degrees
4	
5	
6	MAGNETIC HEADING
7	
8	Range = [-180, +180] degrees
9	
10	
11	
12	LSB = 90/512 degrees
13	STATUS
14	MSB = 512 knot
15	
16	
17	INDICATED AIRSPEED (IAS)
18	
19	Range = [0, 1023] knots
20	
21	
22	
23	LSB = 1 knot
24	STATUS
25	MSB = MACH 2.048
26	
27	
28	MACH NUMBER
29	
30	Range = [0, 4.096] MACH
31	
32	
33	LSB = MACH 0.008
34	STATUS
35	MSB = 1024 knots
36	
37	
38	
39	
40	TRUE AIRSPEED
41	
42	Range = [0, 2048] knots
43	
44	
45	
46	LSB = 0.5 knots
47	STATUS
48	SIGN
49	MSB = 8192 feet/minute
50	
51	ALTITUDE RATE
52	
53	Range = [-16384, +16320] feet/minute
54	
55	
56	LSB = 64 feet/minute

PURPOSE: To provide the ATC system with current measured values of magnetic heading. IAS/MACH, altitude rate and TAS.

Note: *Two's complement coding is used for all signed fields as specified in §B.2.3.2.*

Table B-3-84 to B-3-86: BDS Codes 5,4 to 5,6 – Waypoints 1, 2 and 3

MB FIELD

Bit	Field
1	STATUS (see 1)
2	MSB
3	
4	CHARACTER 1
5	
6	
7	LSB
8	MSB
9	
10	CHARACTER 2
11	
12	
13	LSB
14	MSB
15	
16	CHARACTER 3
17	
18	
19	LSB
20	MSB
21	
22	CHARACTER 4
23	
24	
25	LSB
26	MSB
27	
28	CHARACTER 5
29	
30	
31	LSB
32	MSB = 30 minutes
33	
34	ESTIMATED TIME OF ARRIVAL
35	(NORMAL FLIGHT)
36	
37	Range = [0, 60] minutes
38	
39	
40	LSB = 60/512 minutes
41	MSB = 320 FL
42	
43	ESTIMATED FLIGHT LEVEL
44	(NORMAL FLIGHT)
45	Range = [0, 630] FL
46	LSB = 10 FL
47	MSB = 30 minutes
48	
49	TIME TO GO
50	(DIRECT ROUTE)
51	
52	Range = [0, 60] minutes
53	
54	
55	LSB = 60/512 minutes
56	RESERVED

PURPOSE: To provide information on the next three waypoints,
register 54_{16} contains information on the next waypoint,
register 55_{16} contains information on the next waypoint plus one, and
register 56_{16} contains information on the next waypoint plus two.

1) The single status bit shall be set to ZERO (0) if any of the parameters are invalid.

2) The actual time or flight level shall be calculated from the trajectory scheduled in the FMS.

   Note: *Mode detail on the next waypoint is given in register 41_{16} to 43_{16}.*

3) When the waypoint identity has only three characters, two leading ZERO characters shall be added (e.g., CDN becomes 00CDN).

4) Estimated time is in minutes and all ones shall be used to indicate that the waypoint referred to is one hour or more away.

Table B-3-95: BDS Code 5,F – Quasi-Static Parameter Monitoring

MB FIELD

1	MSB	MCP/FCU SELECTED ALTITUDE
2	LSB	
3		RESERVED
4		
5		RESERVED
6		
7		RESERVED
8		
9		RESERVED
10		
11		RESERVED
12		
13	MSB	NEXT WAYPOINT
14	LSB	
15		RESERVED
16		
17	MSB	FMS VERTICAL MODE
18	LSB	
19	MSB	VHF CHANNEL REPORT
20	LSB	
21	MSB	METEOROLOGICAL HAZARDS
22	LSB	
23	MSB	FMS SELECTED ALTITUDE
24	LSB	
25	MSB	BAROMETRIC PRESSURE
26	LSB	SETTING MINUS 800 mb
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		RESERVED
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		

PURPOSE: To permit the monitoring of changes in parameters that do not normally change very frequently, i.e., those expected to be stable for 5 minutes or more by accessing a single register.

Parameter Monitor Coding:

1) The changing of each parameter shall be monitored by 2 bits. The value 00 shall indicate that no valid data are available on this parameter. The decimal value for this 2-bit field shall be cycled through 1, 2 and 3, each step indicating a change in the monitored parameter.

2) The meteorological hazards subfield shall report changes to turbulence, wind shear, wake vortex, icing and microburst, as in register number 45_{16}.

3) The next waypoint subfield shall report change to data contained in registers 41_{16}, 42_{16} and 43_{16}.

4) The FMS vertical mode shall report change to bits 48 to 51 in register 40_{16}.

Table B-3-96: BDS Code 6,0 – Heading and Speed Report

MB FIELD

1	STATUS
2	SIGN 1=West (e.g., 315 = -45 degrees)
3	MSB = 90 degrees
4	
5	
6	MAGNETIC HEADING
7	
8	Range = [-180, +180] degrees
9	
10	
11	
12	LSB = 90/512 degrees
13	STATUS
14	MSB = 512 knots
15	
16	
17	INDICATED AIRSPEED
18	
19	Range = [0, 1023] knots
20	
21	
22	
23	LSB = 1 knot
24	STATUS
25	MSB = 2.048 MACH
26	
27	
28	MACH
29	
30	Range = [0, 4.092] MACH
31	
32	
33	
34	LSB = 2.048/512 MACH
35	STATUS
36	SIGN 1=Below
37	MSB = 8192 feet/minute
38	
39	
40	BAROMETRIC ALTITUDE RATE
41	
42	Range = [-16384, +16352] feet/minute
43	
44	
45	LSB = 8192/256 = 32 feet/minute
46	STATUS
47	SIGN 1=Below
48	MSB = 8192 feet/minute
49	
50	
51	INERTIAL VERTICAL VELOCITY
52	
53	Range = [-16384, +16352] feet/minute
54	
55	
56	LSB = 8192/256 = 32 feet/minute

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 1: *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.

4) When barometric altitude rate is integrated and smoothed with inertial vertical velocity (baro-inertial information) it shall be transmitted in the Inertial Vertical Velocity field.

   Note 2: *Barometric Altitude Rate contains values solely derived from barometric measurement. The Barometric Altitude Rate is usually very unsteady and may suffer from barometric instrument inertia.*

   Note 3: *The Inertial Vertical Velocity is also providing information on vertical movement of the aircraft but it comes from equipments (IRS, AHRS) using different sources used for navigation. The information is a more filtered and smooth parameter.*

   Note 4: *Two's complement coding is used for all signed fields as specified in §B.2.3.2.*

   Note 5: *Additional implementation guidelines are provided in §B.4.4 of this Appendix.*

Table B-3-97-1: BDS Code 6,1 – Aircraft Status
(Subtype 1: Emergency/Priority Status)

MB FIELD

Bit	Field
1	MSB
2	
3	FORMAT TYPE CODE = 28
4	
5	LSB
6	MSB
7	SUBTYPE CODE = 1
8	LSB
9	MSB
10	EMERGENCY STATE
11	LSB
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
33	
34	RESERVED
35	
36	
37	
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	

PURPOSE: To provide additional information on aircraft status.

Subtype shall be coded as follows:

0 = No information
1 = Emergency/priority status
2 = TCAS RA Broadcast
3 to 7 = Reserved

Emergency state shall be coded as follows:

Value	Meaning
0	No emergency
1	General emergency
2	Lifeguard/Medical
3	Minimum fuel
4	No communications
5	Unlawful interference
6	Downed aircraft
7	Reserved

1) Message delivery shall be accomplished once per 0.8 seconds using the event-driven protocol.

2) Termination of emergency state shall be detected by coding in the surveillance status field of the airborne position message.

3) Subtype 2 message broadcast shall take priority over subtype 1 message broadcast.

4) Emergency State value 1 shall be set when Mode A code 7700 is provided to the transponder.

5) Emergency State value 4 shall be set when Mode A code 7600 is provided to the transponder.

6) Emergency State value 5 shall be set when Mode A code 7500 is provided to the transponder.

Table B-3-97-2: BDS Code 6,1– Aircraft Status
(Subtype 2: Extended Squitter TCAS RA Broadcast)

MB FIELD

Bit	Field
1	MSB
2	
3	FORMAT TYPE CODE = 28
4	
5	LSB
6	MSB
7	SUBTYPE CODE = 2
8	LSB
9	MSB
10	
11	
12	
13	
14	
15	ACTIVE RESOLUTION ADVISORIES
16	
17	
18	
19	
20	
21	
22	LSB
23	MSB
24	RACs RECORD
25	
26	LSB
27	RA TERMINATED
28	MULTIPLE THREAT ENCOUNTER
29	MSB THREAT – TYPE INDICATOR
30	LSB
31	MSB
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	
43	THREAT IDENTITY DATA
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	LSB

PURPOSE: To report resolution advisories (RAs) generated by TCAS equipment.

Subtype shall be coded as follows:

0 = No information
1 = Emergency/priority status
2 = TCAS RA Broadcast
3 to 7 = Reserved

Emergency state shall be coded as follows:

The coding of bits 9 to 56 of this register shall conform to the corresponding bits of Register 30_{16} as specified in Annex 10, Volume IV, §4.3.8.4.2.2.

1) Message delivery shall be accomplished once per 0.8 seconds using the event-driven protocol.

2) RA Broadcast shall begin within 0.5 seconds after transponder notification of the initiation of an TCAS RA.

3) RA Broadcast shall be terminated 10 seconds after the RAT flag (Annex 10, Volume IV, §4.3.8.4.2.2.1.3) transitions from ZERO to ONE.

4) Subtype 2 message broadcast shall take priority over subtype 1 message broadcast.

Table B-3-98: BDS Code 6,2 – Target State and Status Information

MB FIELD

1	
2	
3	FORMAT TYPE CODE = 29
4	
5	
6	MSB SUBTYPE CODE = 0
7	LSB
8	MSB Vertical Data Available / Source Indicator
9	LSB (see §)
10	Target Altitude Type (see §)
11	Backward Compatibility Flag = 0
12	MSB Target Altitude Capability
13	LSB (see §)
14	MSB Vertical Mode Indicator
15	LSB (see §)
16	MSB
17	
18	
19	
20	Target Altitude
21	(see §)
22	
23	
24	
25	LSB
26	MSB Horizontal Data Available / Source Indicator
27	LSB (see §)
28	MSB
29	
30	
31	
32	Target Heading / Track Angle
33	(see §)
34	
35	
36	LSB
37	Target Heading / Track Indicator (see §)
38	MSB Horizontal Mode Indicator (see §)
39	LSB
40	MSB
41	Navigation Accuracy Category – Position (NAC_P)
42	(see §)
43	LSB
44	Navigation Integrity Category – Baro (NIC_{BARO}) (see §)
45	MSB Surveillance Integrity Level (SIL)
46	LSB (see §)
47	
48	
49	Reserved
50	
51	
52	MSB Capability / Mode Codes
53	LSB (see §)
54	MSB
55	Emergency / Priority Status
56	LSB (see §)

PURPOSE: To provide aircraft state and status information.

Table B-3-101: BDS Code 6,5 – Extended Squitter Aircraft Operational Status

MB FIELD

Bit	Field	Field
1	MSB	
2		
3	FORMAT TYPE CODE = 31	
4		
5	LSB	
6	MSB	MSB
7	SUBTYPE CODE = 0	SUBTYPE CODE = 1
8	LSB	LSB
9	MSB	MSB
10		
11		
12		
13		
14	AIRBORNE	SURFACE
15	CAPABILITY CLASS (CC)	CAPABILITY CLASS (CC)
16	CODES	CODES
17	(see §)	(see §)
18		
19		
20		LSB
21		MSB
22		LENGTH/WIDTH CODES
23		(see §)
24	LSB	LSB
25	MSB	
26		
27		
28		
29		
30		
31		
32	OPERATIONAL MODE (OM) CODES	
33	(see §)	
34		
35		
36		
37		
38		
39		
40	LSB	
41	MSB	
42	VERSION NUMBER (see §)	
43	LSB	
44	NIC SUPPLEMENT (see §)	
45	MSB	
46	NAVIGATIONAL ACCURACY CATEGORY – POSITION	
47	(NAC_P) (see §)	
48	LSB	
49	MSB BAQ = 0	RESERVED
50	LSB (see §)	
51	MSB SURVEILLANCE INTEGRITY LEVEL (SIL)	
52	LSB (see §)	
53	NIC_{BARO} (see §)	TRK/HDG (see §)
54	HRD (see §)	
55	RESERVED	
56		

PURPOSE: To provide the capability class and current operational mode of ATC-related applications and other operational information..

Subtype Coding:

0 = Airborne Status Message
1 = Surface Status Message
2 – 7 = Reserved

1) Message delivery shall be accomplished using the event-driven protocol.

Table B-3-227: BDS Code E,3 – Transponder Type / Part Number

MB FIELD

Bit		
1	STATUS	
2	MSB FORMAT TYPE	
3	LSB	
4	MSB	MSB
5	P/N	
6	Digit 1	CHARACTER 1
7	LSB	
8	MSB	
9	P/N	LSB
10	Digit 2	MSB
11	LSB	
12	MSB	CHARACTER 2
13	P/N	
14	Digit 3	
15	LSB	LSB
16	MSB	MSB
17	P/N	
18	Digit 4	CHARACTER 3
19	LSB	
20	MSB	
21	P/N	LSB
22	Digit 5	MSB
23	LSB	
24	MSB	CHARACTER 4
25	P/N	
26	Digit 6	
27	LSB	LSB
28	MSB	MSB
29	P/N	
30	Digit 7	CHARACTER 5
31	LSB	
32	MSB	
33	P/N	LSB
34	Digit 8	MSB
35	LSB	
36	MSB	CHARACTER 6
37	P/N	
38	Digit 9	
39	LSB	LSB
40	MSB	MSB
41	P/N	
42	Digit 10	CHARACTER 7
43	LSB	
44	MSB	
45	P/N	LSB
46	Digit 11	MSB
47	LSB	
48	MSB	CHARACTER 8
49	P/N	
50	Digit 12	
51	LSB	LSB
52		
53		
54	RESERVED	RESERVED
55		
56		

PURPOSE: To provide Mode-S transponder part number or type as defined by the supplier.

FORMAT TYPE CODING:

Bit 2	Bit 3	
0	0	= Part number (P/N) coding
0	1	= Character coding
1	0	= Reserved
1	1	= Reserved

1) When available it is recommended to use the part number. P/N Digits are BCD encoded. Digit 1 is the first left digit of the part number.

2) If the part number is not available, the first 8 characters of the commercial name can be used with the format type "01."

3) If format type "01" is used, the coding of character 1 to 8 shall be as defined in Table B-2-1. Character 1 is the first left character of the transponder type.

4) For operational reasons, some military installations may not implement this format.

Table B-3-228: BDS Code E,4 – Transponder Software Revision Number

MB FIELD

1	STATUS	
2	MSB FORMAT TYPE	
3	LSB	
4	MSB	MSB
5	P/N	
6	Digit 1	CHARACTER 1
7	LSB	
8	MSB	
9	P/N	LSB
10	Digit 2	MSB
11	LSB	
12	MSB	CHARACTER 2
13	P/N	
14	Digit 3	
15	LSB	LSB
16	MSB	MSB
17	P/N	
18	Digit 4	CHARACTER 3
19	LSB	
20	MSB	
21	P/N	LSB
22	Digit 5	MSB
23	LSB	
24	MSB	CHARACTER 4
25	P/N	
26	Digit 6	
27	LSB	LSB
28	MSB	MSB
29	P/N	
30	Digit 7	CHARACTER 5
31	LSB	
32	MSB	
33	P/N	LSB
34	Digit 8	MSB
35	LSB	
36	MSB	CHARACTER 6
37	P/N	
38	Digit 9	
39	LSB	LSB
40	MSB	MSB
41	P/N	
42	Digit 10	CHARACTER 7
43	LSB	
44	MSB	
45	P/N	LSB
46	Digit 11	MSB
47	LSB	
48	MSB	CHARACTER 8
49	P/N	
50	Digit 12	
51	LSB	LSB
52		
53		
54	RESERVED	RESERVED
55		
56		

PURPOSE: To provide Mode-S transponder software revision number as defined by the supplier.

FORMAT TYPE CODING:

Bit 2	Bit 3	
0	0	= Part number (P/N) coding
0	1	= Character coding
1	0	= Reserved
1	1	= Reserved

1) When a part number is allocated to the software revision, it is recommended to use the format type "00." In this case, P/N Digits are BCD encoded. Digit 1 is the first left digit of the part number.

2) If format type "01" is used, the coding of character 1 to 8 shall be as defined in Table B-2-1. Character 1 is the first left character of the software revision number.

3) For operational reasons, some military installations may not implement this format.

Table B-3-229: BDS Code E,5 – TCAS/ACAS Unit Part Number

MB FIELD

Bit	Part number (P/N) coding	Character coding
1	STATUS	
2	MSB FORMAT TYPE	
3	LSB	
4	MSB	MSB
5	P/N	
6	Digit 1	CHARACTER 1
7	LSB	
8	MSB	
9	P/N	LSB
10	Digit 2	MSB
11	LSB	
12	MSB	CHARACTER 2
13	P/N	
14	Digit 3	
15	LSB	LSB
16	MSB	MSB
17	P/N	
18	Digit 4	CHARACTER 3
19	LSB	
20	MSB	
21	P/N	LSB
22	Digit 5	MSB
23	LSB	
24	MSB	CHARACTER 4
25	P/N	
26	Digit 6	
27	LSB	LSB
28	MSB	MSB
29	P/N	
30	Digit 7	CHARACTER 5
31	LSB	
32	MSB	
33	P/N	LSB
34	Digit 8	MSB
35	LSB	
36	MSB	CHARACTER 6
37	P/N	
38	Digit 9	
39	LSB	LSB
40	MSB	MSB
41	P/N	
42	Digit 10	CHARACTER 7
43	LSB	
44	MSB	
45	P/N	LSB
46	Digit 11	MSB
47	LSB	
48	MSB	CHARACTER 8
49	P/N	
50	Digit 12	
51	LSB	LSB
52		
53		
54	RESERVED	RESERVED
55		
56		

PURPOSE: To provide TCAS/ACAS unit part number or type as defined by the supplier.

FORMAT TYPE CODING:

Bit 2	Bit 3	
0	0	= Part number (P/N) coding
0	1	= Character coding
1	0	= Reserved
1	1	= Reserved

1) When available it is recommended to use the part number. P/N Digits are BCD encoded. Digit 1 is the first left digit of the part number.

2) If the part number is not available, the first 8 characters of the commercial name can be used with the format type "01."

3) If format type "01" is used, the coding of character 1 to 8 shall be as defined in Table B-2-1. Character 1 is the first left character of the TCAS/ACAS unit type.

4) For operational reasons, some military installations may not implement this format.

Table B-3-230: BDS Code E,6 – TCAS/ACAS Unit Software Revision

MB FIELD

Bit		
1	STATUS	
2	MSB FORMAT TYPE	
3	LSB	
4	MSB	MSB
5	P/N	
6	Digit 1	CHARACTER 1
7	LSB	
8	MSB	
9	P/N	LSB
10	Digit 2	MSB
11	LSB	
12	MSB	CHARACTER 2
13	P/N	
14	Digit 3	
15	LSB	LSB
16	MSB	MSB
17	P/N	
18	Digit 4	CHARACTER 3
19	LSB	
20	MSB	
21	P/N	LSB
22	Digit 5	MSB
23	LSB	
24	MSB	CHARACTER 4
25	P/N	
26	Digit 6	
27	LSB	LSB
28	MSB	MSB
29	P/N	
30	Digit 7	CHARACTER 5
31	LSB	
32	MSB	
33	P/N	LSB
34	Digit 8	MSB
35	LSB	
36	MSB	CHARACTER 6
37	P/N	
38	Digit 9	
39	LSB	LSB
40	MSB	MSB
41	P/N	
42	Digit 10	CHARACTER 7
43	LSB	
44	MSB	
45	P/N	LSB
46	Digit 11	MSB
47	LSB	
48	MSB	CHARACTER 8
49	P/N	
50	Digit 12	
51	LSB	LSB
52		
53		
54	RESERVED	RESERVED
55		
56		

PURPOSE: To provide TCAS/ACAS unit software revision number as defined by the supplier.

FORMAT TYPE CODING:

Bit 2	Bit 3	
0	0	= Part number (P/N) coding
0	1	= Character coding
1	0	= Reserved
1	1	= Reserved

1) When available it is recommended to use the part number. P/N Digits are BCD encoded. Digit 1 is the first left digit of the part number.

2) If format type “01” is used, the coding of character 1 to 8 shall be as defined in Table B-2-1. Character 1 is the first left character of the TCAS/ACAS unit software revision.

3) For operational reasons, some military installations may not implement this format.

Table B-3-241: BDS Code F,1 – Military Applications

MB FIELD

1	STATUS	
2	Character Field (see 1)	
3	C1	
4	A1	
5	C2	
6	A2	
7	C4	
8	A4	MODE 1 CODE
9	X	
10	B1	
11	D1	
12	B2	
13	D2	
14	B4	
15	D4	
16	STATUS	
17	C1	
18	A1	
19	C2	
20	A2	
21	C4	
22	A4	MODE 2 CODE
23	X	
24	B1	
25	D1	
26	B2	
27	D2	
28	B4	
29	D4	
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		RESERVED
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		

PURPOSE: To provide data in support of military applications.

1) The character field shall be used to indicate whether 2 characters or 4 characters are used in the Mode 1 code. The logic shall be as follows:

   0 = 2 octal codes
   (A1 – A4 and B1 – B4)

   1 = 4 octal codes
   (A1 – A4, B1 – B4, C1 – C4 and D1 – D4)

2) The status fields shall be used to indicate whether the data are available or unavailable. The logic shall be as follows:

   0 = Unavailable
   1 = Available

Table B-3-242: BDS Code F,2 – Military Applications

MB FIELD

1	MSB	
2		
3	AF=2, TYPE CODE = 1	
4		
5	LSB	
6	STATUS	
7	CHARACTER FIELD (see 1)	
8	C1	
9	A1	
10	C2	
11	A2	
12	C4	
13	A4	
14	X	MODE 1 CODE
15	B1	
16	D1	
17	B2	
18	D2	
19	B4	
20	D4	
21	STATUS	
22	C1	
23	A1	
24	C2	
25	A2	
26	C4	
27	A4	
28	X	MODE 2 CODE
29	B1	
30	D1	
31	B2	
32	D2	
33	B4	
34	D4	
35	STATUS	
36	C1	
37	A1	
38	C2	
39	A2	
40	C4	
41	A4	
42	X	MODE A CODE
43	B1	
44	D1	
45	B2	
46	D2	
47	B4	
48	D4	
49		
50		
51		
52		RESERVED
53		
54		
55		
56		

PURPOSE: This register is used for military applications involving DF=19. Its purpose is to provide data in support of military applications.

'TYPE CODE' shall be encoded as follows:

0 = Unassigned
1 = Mode code information
2-31 = Unassigned

1) The character field shall be used to indicate whether 2 characters or 4 characters are used in the Mode 1 code. The logic shall be as follows:

0 = 2 octal codes
(A1 – A4 and B1 – B4)

1 = 4 octal codes
(A1 – A4, B1 – B4, C1 – C4 and D1 – D4)

2) The status fields shall be used to indicate whether the data are available or unavailable. The logic shall be as follows:

0 = Unavailable
1 = Available

DF = 19 Application Field (AF) shall be encoded as follows:

0 = Reserved for civil Extended Squitter formats
1 = Reserved for formation flight
2 = Reserved for military applications
3-7 = Reserved

B.4 Implementation Guidelines

This section provides implementation guidelines on data formats for applications using Mode S Specific Services contained in this Appendix. The section is intended for use by the avionics industry and by the developers of air traffic services (ATS) applications.

B.4.1 Transponder Register 20_{16} (ICAO Doc 9871, §C.2.4.3)

B.4.1.1 Airborne Function

Annex 10, Volume IV requirements (Annex 10, Volume IV, §3.1.2.9.1.1) state the following for data in transponder register 20_{16}:

> *AIS, aircraft identification subfield in MB.* The transponder shall report the aircraft identification in the 48-bit (41 – 88) AIS subfield of MB. The aircraft identification transmitted shall be that employed in the flight plan. When no flight plan is available, the registration marking of the aircraft shall be inserted in this subfield.
>
> ***Note:*** *When the registration marking of the aircraft is used, it is classified as 'fixed direct data' (see Annex 10 Vol. IV, §3.1.2.10.5.1.1). When another type of aircraft identification is used, it is classified as 'variable direct data' (see Annex 10 Vol. IV, §3.1.2.10.5.1.3)."*

When the aircraft installation does not use an external source to provide the aircraft identification (most of the time it will be the call sign used for communications between pilot and controllers), the text above means that the aircraft identification is considered as variable direct data. It also means that such data characterize the flight condition of the aircraft (not the aircraft itself) and are therefore subject to dynamic changes. It further means that variable direct data are also subject to the following requirement when data become unavailable.

Paragraph §B.2.2 states:

> "If data are not available for a time no greater than twice the specified maximum update interval or 2 seconds (whichever is the greater), the status bit (if specified for that field) shall indicate that the data in that field are invalid and the field shall be zeroed."

Therefore, if the external source providing the aircraft identification fails or delivers corrupted data, transponder Register 20_{16} should be zeroed. It should not include the registration marking of the aircraft since the airborne installation has initially been declared as providing variable direct data for the aircraft identification.

The loss of the aircraft identification data will be indicated to the ground since transponder Register 20_{16} will be broadcast following its change. If the registration marking of the aircraft was inserted in lieu of the call sign following a failure of the external source, it would not help the ground systems since the registration marking of the aircraft is not the information that was inserted in the aircraft flight plan being used by the ground ATC systems.

In conclusion, the aircraft identification is either fixed (aircraft registration) or variable direct data (call sign). It depends whether the aircraft installation uses a data source providing the call sign; if so, data contained in transponder Register 20_{16} should meet the requirement of the SARPs. When data becomes unavailable because of a data source failure, transponder Register 20_{16} should contain ALL ZEROs.

B.4.1.2 Ground Considerations

Aircraft identification data can be used to correlate surveillance information with flight plan information. If the data source providing the aircraft identification fails, the aircraft identification information will no longer be available in the surveillance data flow. In this case, the following means could enable the ground system to continue correlating the surveillance and flight plan information of a given target.

If the aircraft identification is used to correlate surveillance and flight plan data, extra information such as the Mode A code, if any, and the ICAO 24-bit aircraft address of the target could be provided to the flight data processing system. This would enable the update of the flight plan of the target with this extra information.

In case the aircraft identification becomes unavailable, it would still be possible to correlate both data flows using (for example) the ICAO 24-bit aircraft address information to perform the correlation. It is therefore recommended that ground systems update the flight plan of a target with extra identification information that is available in the surveillance data flow, e.g., the ICAO 24-bit aircraft address, the Mode A code (if any) or the tail number (if available from transponder Register 21_{16}).

This extra identification information might then be used in lieu of the aircraft identification information contained in transponder Register 20_{16} in case the data source providing this information fails.

B.4.2 Transponder Register 40_{16} (ICAO Doc 9871, §C.2.4.4)

Paragraph §B.5.2.1 gives a general example of what are the different selected altitudes and the relationship with the target altitude and introduces the meaning of the different parameters and notions used in this section.

Paragraphs §B.5.2.2, §B.5.2.3 and §B.5.2.4 provide more detailed information for some specific platforms.

B.4.2.1 General Example for the Loading of Data in Register 40_{16}

Figure B-4-2 provides a general example for the loading of data in Register 40_{16}.

The goal of Figure B-4-2 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.

Notions and terms used:

- Cleared flight level: Flight level cleared by the controller, i.e., the flight level aircraft should reach and maintain.

- MCP/FCU selected altitude:

  - The Autopilot Flight Director System (AFDS) is more commonly known as autopilot (A/P). Its task is to laterally and vertically control the aircraft when selected by the crew. In general in modern aircraft, the AFDS is a system consisting of several individual Flight Control Computers (FCCs) and a single Flight Control Panel (FCP) mounted directly between the pilots just under the windshield. Fundamentally, the autopilot attempts to acquire or maintain target parameters determined either by manual inputs made by the pilot or by computations from the Flight Management System.

  - MCP: Mode Control Panel is the usual name given on Boeing platforms to the FCP which provides control of the Autopilot, Flight Director, Altitude Alert and Autothrottle System. The MCP is used to select and activate Autopilot Flight Director System (AFDS) modes and establish altitudes, speeds and climb/descent profiles.

  - FCU: Flight Control Unit is similar to MCP but for Airbus platforms.

  - MCP/FCU selected altitude: The altitude set by pilots on the MCP/FCU controlling the auto-pilot system. In the great majority of cases pilots set the MCP/FCU altitude to the altitude cleared by Air Traffic Control (ATC) before engaging a vertical mode. The autopilot will try to reach this MCP/FCU selected altitude using different selectable vertical modes: constant vertical rate (e.g., V/S), Flight Level change at a given airspeed (e.g., FL CH), vertical path given by the FMS (VNAV), and maintain it using the altitude hold mode (ALT HOLD).

    Note: *If the aircraft is not equipped with an autopilot this information may be derived from equipment generating an alert when the FL is reached (e.g., altitude alerter system).*

- FMS selected altitude:

  - The Flight Management System (FMS or FMC for Flight Management Computer) is a computer onboard aircraft that controls the navigation, performance, flight planning, and guidance aspects of flight. The FMS navigation component determines where the aircraft is. The FMS performance component calculates necessary performance data. The FMS flight planning component allows for the creation and modification of flight plans. The FMS guidance component issues commands necessary to guide the aircraft along the route programmed into the FMS. The current and programmed paths of the aircraft are monitored three-dimensionally, by flying from waypoint to waypoint and by obeying crossing restrictions.

  - o The FMS guidance component will therefore compute selected altitude constraints to be reached at different points. This is known as FMS selected altitude. These selected altitudes are used to control the aircraft in specific modes of autopilot for example when Vertical Navigation mode (VNAV) is selected on MCP/FCU. VNAV mode is the highest level of vertical profile automation, and maximizes fuel economy.

- ➢ Target altitude: this is the next altitude at which the aircraft will level-off if in a climb or descent, or the aircraft current intended altitude if it is intending to hold its altitude.

  - o The target altitude may be:

    - The MCP/FCU selected altitude when the autopilot is directly controlled by command entered by the crew()

    - The FMS selected altitude when in VNAV or similar modes.

    - The current altitude.

    - Unknown.

- ➢ MCP/FCU mode bits:

  - o VNAV indicates when a VNAV or equivalent mode in which the A/P is controlled by FMS is selected.

  - o ALT HOLD indicates when A/P Alt Hold mode is selected. It does not correspond to a general altitude capture and does not cover VNAV hold situation.

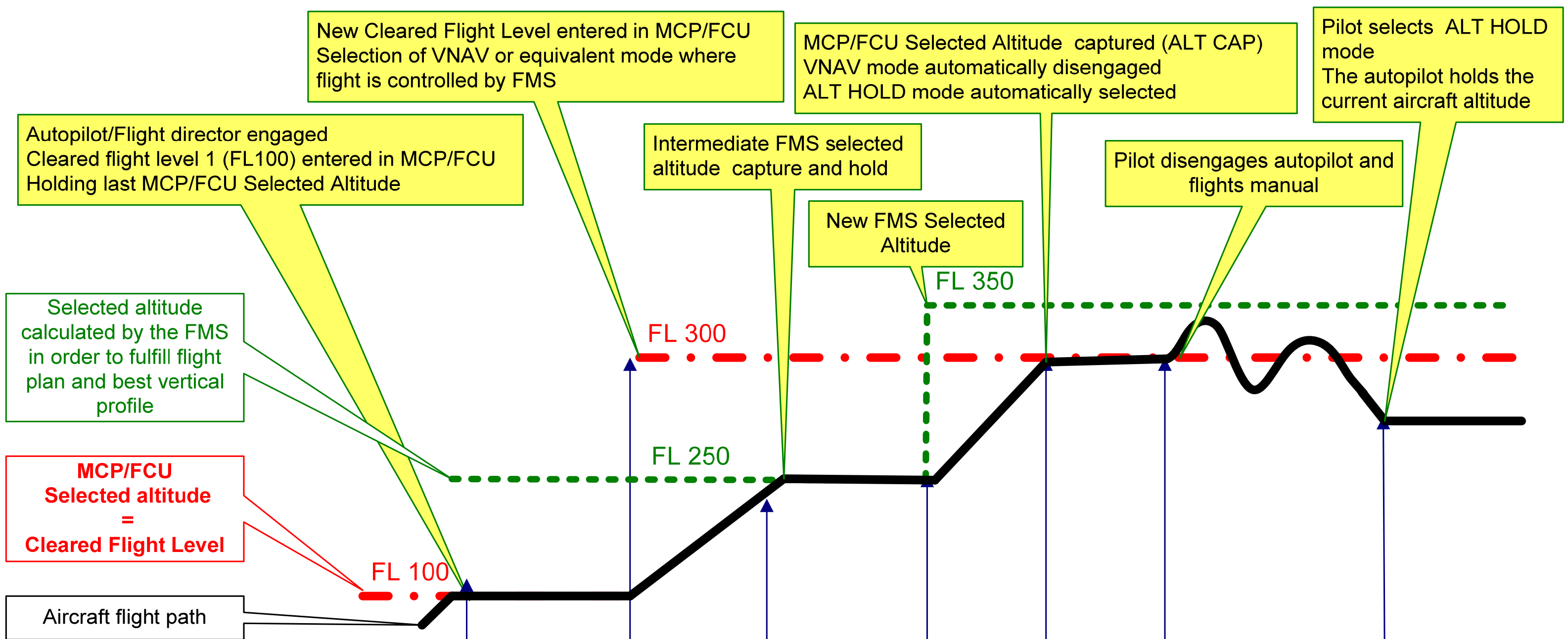
  - o Approach indicates that a mode to capture ILS localizer and glide slope is engaged.

- ➢ Priority of MCP/FCU selected altitude on FMS selected altitude:

  The MCP/FCU selected altitude is the altitude that the aircraft shall not violate and therefore it has always priority on FMS selected altitude.

EXAMPLE for the loading of data in Register 40Hex

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			1	2	3	4	5	6	7
	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	unknown	Altitude
Step			1	2	3	4	5	6	7

Figure B-4-2: General Example for the Loading of Data in Register 40_{16}

Explanation of the different steps in Figure B-4-2:

Generally, Figure B-4-2 shows a theoretical sequence of cases which should not be considered as a real operational sequence. For example, some steps may be more realistic when the aircraft is in descent.

Step 1: The MCP/FCU selected altitude has been set to first cleared flight level (FL100). The Autopilot/Flight Director is engaged and the aircraft is holding the latest MCP/FCU selected altitude which has been reached before Step1. The target altitude is the MCP/FCU selected altitude. VNAV mode is not engaged. The FMS selected altitude is not the target altitude.

Step 2: A new clear flight level has been allocated to the aircraft by ATC. The pilot has entered this value into the MCP/FCU resulting in a new MCP/FCU selected altitude. The pilot has engaged the VNAV mode. The aircraft speed/path is determined by the FMS. The FMS contains a flight path with an altitude restriction at a given waypoint (FL250). The FMS selected altitude corresponds to the associated altitude restriction. This FMS selected altitude is less than the MCP/FCU selected altitude and therefore becomes the target altitude to which the aircraft is climbing.

Step 3: There is an altitude restriction associated with a waypoint. The aircraft has captured and is maintaining the FMS selected altitude until crossing the way point. The VNAV mode remains active. In an operational environment, aircrew should also set the MCP/FCU altitude to the intermediate levels on a stepped climb SID if workload permits.

Step 4: The waypoint with restricted altitude is passed. A new FMS selected altitude is now valid. The aircraft resumes its climbing to try to reach this new FMS selected altitude. VNAV mode is still engaged. Although the aircraft is trying to reach the FMS selected altitude (FL350) it will level-off at the MCP/FCU selected altitude which is lower than the FMS selected altitude therefore the selected altitude is the MCP/FCU selected altitude.

Step 5: The MCP/FCU selected altitude is lower than the FMS selected altitude. The aircraft therefore first approaches this MCP/FCU selected altitude which is a limit to not violate. This MCP/FCU altitude is captured and held by the aircraft. This automatically disengages the VNAV mode.

Step 6: The flight crew has disengaged the autopilot and is flying the aircraft manually. The target altitude is not known. However on an operational point of view it must be noted that such mode would not be allowed in regulated airspace unless the aircrew had declared an emergency or had obtained a new ATC clearance. In the latter case the ATC clearance should be entered in the MCP/FCU. It is more probable that this case may happen on a “descent when ready” profile. In all cases the MCP/FCU selected altitude may still be useful because it should be the value used in the altitude alerter.

Step 7: The pilot selects altitude hold (Alt Hold or equivalent mode) making the current altitude equivalent to the target altitude. Note that although MCP/FCU selected altitude could become the same (pilot entering the new flight level in the MCP/FCU) this is not mandatory and therefore only altitude represents with full confidence the level the aircraft is maintaining.

B.4.2.1.1 Target Altitude Summary

If MCP/FCU altitude is between your current altitude and FMS Selected Altitude, then the target altitude is MCP/FCU. If VNAV is engaged and the previous case is not in effect, then FMS is the target altitude. If Alt Hold is selected and the current altitude is not equal to either of the selected altitudes, then target altitude is altitude.

B.4.2.1.2 Possible Uses of Selected Altitude and Target Altitude

1. MCP/FCU selected altitude will be downlinked as an additional read-back in order to check that the cleared flight level has been correctly understood and entered in the airborne system by the pilot.

2. Target altitude and associated mode of flight may be of interest to reduce the Short Term Conflict Alert false alarm rate.

B.4.2.1.3 Target Altitude Implementation Difficulties

It is recognized that all information to determine which altitude is the target altitude or which mode of flight is currently used may not always be available to the transponder in the current airborne implementation. In addition it may be very dependent on the platform. It is therefore preferable to set to 0 the corresponding bits of register 40_{16} rather than sending wrong information.

B.4.2.2 Transponder Register Number 40_{16} on Airbus Aircraft

B.4.2.2.1 Target Altitude

In order to clarify how aircraft intention information is reported in transponder Register 40_{16} a mapping (Table B-4-1) has been prepared to illustrate, for a number of conditions:

a) how the altitude data are derived that are loaded into transponder Register 40_{16}, and

b) how the corresponding source bits are set.

B.4.2.2.1.1 A330/A340 Family

Table B-4-1: Transponder Register Number 40_{16} on Airbus A330/340 Aircraft

Auto Pilot or Flight Director Status	**Auto Pilot or Flight Director Vertical Mode**	**Conditions: Vertical Status/Altitude (FCU, FMS or Aircraft)**	**Target Altitude used**	**Bit 55**	**Bit 56**
(AP on and FD on/off) or (AP off and FD on)	Vertical Speed (V/S)	V/S > (<) 0 with FCU ALT > (<) A/C ALT	FCU ALT	1	0
		V/S > (<) 0 with FCU ALT < (>) A/C ALT	/	0	0
		V/S = 0	A/C ALT	0	1
	Flight Path Angle (FPA)	FPA > (<) 0 with FCU ALT > (<) A/C ALT	FCU ALT	1	0
		FPA > (<) 0 with FCU ALT < (>) A/C ALT	/	0	0
		FPA = 0	A/C ALT	0	1
	Altitude Acquire (ALT CAPT)	Aircraft operating with FCU altitude	FCU ALT	1	0
	Altitude Acquire (ALT CAPT)	Aircraft capturing a constrained altitude imposed by the FMS	FMS ALT	1	1
	Altitude Hold (ALT)		A/C ALT	0	1
	Descent (DES)	FCU ALT > next FMS ALT	FCU ALT	1	0
		FCU ALT next FMS ALT	FMS ALT	1	1
		No next FMS ALT	FCU ALT	1	0
	Open Descent (OPEN DES)	Mode used to descend directly to the FCU ALT disregarding the computed descent path and FMS constraints	FCU ALT	1	0
	Climb (CLB)	FCU ALT < next FMS ALT	FCU ALT	1	0
		FCU ALT next FMS ALT	FMS ALT	1	1
		No next FMS ALT	FCU ALT	1	0
	Open Climb (OPEN CLB)	Mode used to climb directly to the FCU ALT disregarding the computed descent path and FMS constraints	FCU ALT	1	0
	Take Off (TO)	FCU ALT < next FMS ALT	FCU ALT	1	0
		FCU ALT next FMS ALT	FMS ALT	1	1
		No next FMS ALT	FCU ALT	1	0
	Go Around (GA)	FCU ALT > A/C ALT and FCU ALT < next FMS ALT	FCU ALT	1	0
		FCU ALT > A/C ALT and FCU ALT next FMS ALT	FMS ALT	1	1
		FCU ALT > A/C ALT and no next FMS ALT	FCU ALT	1	0
		FCU ALT A/C ALT	/	0	0
	Other vertical modes (final approach, land, glide slope)		/	0	0
AP off and FD off			/	0	0

B.4.2.2.1.2 A320 Family

Table B-4-2: Transponder Register Number 40_{16} on Airbus A320 Aircraft

Auto Pilot or Flight Director Status	Auto Pilot or Flight Director Vertical Mode	Conditions: Vertical Status/Altitude (FCU, FMS or Aircraft)	Target Altitude used	Bit 55	Bit 56
(AP on and FD on/off) or (AP off and FD on)	Vertical Speed (V/S)	V/S > (<) 0 with FCU ALT > (<) A/C ALT	FCU ALT	1	0
		V/S > (<) 0 with FCU ALT < (>) A/C ALT	/	0	0
		V/S = 0	A/C ALT	0	1
	Flight Path Angle (FPA)	FPA > (<) 0 with FCU ALT > (<) A/C ALT	FCU ALT	1	0
		FPA > (<) 0 with FCU ALT < (>) A/C ALT	/	0	0
		FPA = 0	A/C ALT	0	1
	Altitude Acquire (ALT CAPT)	Aircraft operating with FCU altitude	FCU ALT	1	0
	Altitude Acquire (ALT CAPT)	Aircraft capturing a constrained altitude imposed by the FMS	FMS ALT	1	1
	Altitude Hold (ALT)		A/C ALT	0	1
	Descent (DES) or Immediate Descent (IM DES)	FCU ALT > next FMS ALT	FCU ALT	1	0
		FCU ALT next FMS ALT	FMS ALT	1	1
		No next FMS ALT	FCU ALT	1	0
	Open Descent (OPEN DES) or Expedite (EXP)	Mode used to descend directly to the FCU ALT disregarding the computed descent path and FMS constraints	FCU ALT	1	0
	Climb (CLB) or Immediate Climb (IM CLB)	FCU ALT < next FMS ALT	FCU ALT	1	0
		FCU ALT next FMS ALT	FMS ALT	1	1
		No next FMS ALT	FCU ALT	1	0
	Open Climb (OPEN CLB) or Expedite (EXP)	Mode used to climb directly to the FCU ALT disregarding the computed descent path and FMS constraints	FCU ALT	1	0
	Take Off (TO)	FCU ALT < next FMS ALT	FCU ALT	1	0
		FCU ALT next FMS ALT	FMS ALT	1	1
		No next FMS ALT	FCU ALT	1	0
	Go Around (GA)	FCU ALT > A/C ALT and FCU ALT < next FMS ALT	FCU ALT	1	0
		FCU ALT > A/C ALT and FCU ALT next FMS ALT	FMS ALT	1	1
		FCU ALT > A/C ALT and no next FMS ALT	FCU ALT	1	0
		FCU ALT A/C ALT	/	0	0
	Other vertical modes (final approach, land, glide slope)		/	0	0
AP off and FD off			/	0	0

The A320 (see Table B-4-3) has two additional modes compared to the A330/A340:

- The Expedite Mode: it climbs or descends at, respectively, "green dot" speed or V_{max} speed.
- The Immediate Mode: it climbs or descends immediately while respecting the FMS constraints.

B.4.2.2.1.3 Synthesis

Table B-4-1 and Table B-4-2 show the following:

a) Depending on the AP/FD vertical modes and some conditions, the desired "target" altitude might differ. Therefore a logical software combination should be developed in order to load the appropriate parameter in transponder Register 40_{16} with its associated source bit value and status.

b) A large number of parameter values are required to implement the logic: the V/S, the FCU ALT, the A/C ALT, the FPA, the FMS ALT and the AP/FD status and vertical modes. The following labels might provide the necessary information to satisfy this requirement:

1.	V/S: label 212	(Vertical Rate) from ADC
2.	FCU ALT: label 102 from FCC	(Selected Altitude)
3.	A/C ALT: label 361 from IRS/ADIRS	(Inertial Altitude)
4.	FPA: label 322 from FMC	(Selected Altitude)
5.	FMS ALT: label 102 from FMC	(Selected Altitude)
6.	AP/FD: labels 272 273 (Arm modes) and 274 (Pitch modes)	(Auto-throttle modes)

The appropriate "target" altitude should, whatever its nature (A/C, FMS or FCU), be included in a dedicated label (e.g., 271) which would be received by the GFM that will then include it in transponder Register 40_{16}. A dedicated label (such as label 271) could then contain the information on the source bits for target altitude. This is demonstrated graphically in Figure B-4-3.

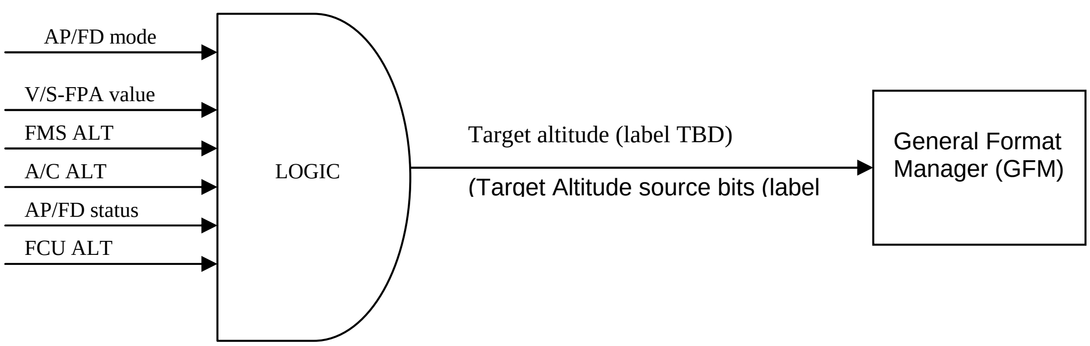


Figure B-4-3: Logic to Derive the Target Altitude Data Information

B.4.2.2.2 Selected Altitude from the Altitude Control Panel

When selected altitude from the altitude control panel is provided in bits 1 to 13, the status and mode bits (48 – 51) may be provided from the following sources:

	A320	**A340**
Status of altitude control panel mode bits (bit 48)	SSM labels 273/274	SSM labels 274/275
Managed Vertical Mode (bit 49)	Label 274 bit 11 (climb) Label 274 bit 12 (descent) Bus FMGC A	Label 275 bit 11 (climb) Label 275 bit 15 (descent) Bus FMGEC G GE-1
Altitude Hold Mode (bit 50)	Label 274 bit 19 (Alt mode) Bus FMGC A	Label 275 bit 20 (Alt hold) Bus FMGEC G GE-1
Approach Mode (bit 51)	Label 273 bit 23 Bus AFS FCU	Label 273 bit 15 Bus AFS FCU

B.4.2.2.3 Transponder Register 40_{16} on Boeing 747-400, 757 and 767 Aircraft

In order to clarify how selected altitude information from the altitude control panel and target altitude is reported in transponder Register 40_{16}, a mapping has been prepared to illustrate how the status and mode bits can be derived.

Transponder Register bit #	**Description**	**Label**
48	Status of mode bits	SSM of 272 and 273
49	Managed Vertical Mode	272 bit 13
50	Altitude Hold Mode	272 bit 9 / 273 bit 19
51	Approach Mode	272 bit 9 / 273 bit 19
54	Status of Target Altitude source bits	SSM of new label (TBD)
55 – 56	Target Altitude source bits	New label (TBD)

The selected altitude from the mode control panel may be obtained from label 102 (source ID 0A1). The status bit may be derived from the SSM of label 102.

B.4.2.2.4 Setting of the Target Altitude Source Bits (Bits 54 – 56)

These bits should be set as required in Table B-3-64, item 5:

Bit 54 indicates 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, indicate target altitude source:

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

Aircraft which are not equipped with the logic described in §B.4.1.1 and §B.4.1.2 are not able to determine the target altitude source of the aircraft. In that case bit 54 should be set to 0 (no source information provided) and bits 55 and 56 should be set to 00 (unknown).

B.4.3 Transponder Register 50_{16} (ICAO Doc 9871, §C.2.4.5)

When ARINC 429 data is used, the following is an example implementation:

BDS Bit #:	Data Bit #	Description
1	STATUS	1 = Valid Data
2	SIGN	1 = left (left wing down)
3		MSB = 45 degrees
4		
5		Roll Angle
6		ARINC Label 325
7		
8		Range = [-90, +90]
9		
10		
11		LSB = 45 / 256 degrees
12	STATUS	1 = Valid Data
13	SIGN	1 = west (e.g., 315º = 45º)
14		MSB = 90 degrees
15		
16		
17		True Track Angle
18		ARINC Label 313
19		
20		Range = [-180, +180]
21		
22		
23		LSB = 90 / 512 degrees
24	STATUS	1 = Valid Data
25		MSB = 1024 knots
26		
27		
28		Ground Speed
29		ARINC Label 312
30		
31		Range = [0, 2046]
32		
33		
34		LSB = 1024 / 512 = 2 knots
35	STATUS	1 = Valid Data
36	SIGN	1 = minus
37		MSB = 8 degrees per second
38		
39		Track Angle Rate
40		ARINC Label 335
41		
42		Range = [-16, +16]
43		
44		
45		LSB = 8 / 256 degrees per second
46	STATUS	1 = Valid Data
47		MSB = 1024 knots
48		
49		True Air Speed
50		ARINC Label 210
51		
52		Range = [0, 2046]
53		
54		
55		
56		LSB = 1024 / 512 = 2 knots

The status bits are determined as explained in §B.2.3.2. The data is rounded as specified in §B.2.3.2. The encoding accuracy of the data in the subfield is ±½ LSB by rounding.

For ARINC GAMA configuration, label 335 is not used for the track angle rate but for another parameter. For this particular ARINC configuration the track angle rate field should be loaded with ALL ZEROs. In such cases, ground applications can compute the equivalent of the track angle rate thanks to the true air speed and the roll angle information.

B.4.4 Transponder Register 60_{16} (ICAO Doc 9871, §C.2.4.6)

When ARINC 429 data is used, the following is an example implementation:

BDS Bit #:	Data Bit #	Description
1	STATUS	1 = Valid Data
2	SIGN	1 = West (e.g., 315º = 45º)
3		MSB = 90 degrees
4		
5		Magnetic Heading
6		ARINC Label 320
7		
8		Range = [-90, +90]
9		
10		
11		
12		LSB = 90 / 512 degrees
13	STATUS	1 = Valid Data
14		MSB = 512 knots
15		
16		
17		Indicated Air Speed
18		ARINC Label 206
19		
20		Range = [0, 1023]
21		
22		
23		LSB = 512 / 512 = 1 knot
24	STATUS	1 = Valid Data
25		MSB = 2048
26		
27		
28		Mach
29		ARINC Label 205
30		
31		Range = [0, 4092]
32		
33		
34		LSB = 2048 / 512
35	STATUS	1 = Valid Data
36	SIGN	1 = below
37		MSB = 8192 ft/min
38		
39		Barometric Altitude Rate
40		ARINC Label 212
41		
42		Range = [-16384, +16352]
43		
44		
45		LSB = 8192 / 256 = 32 ft/min
46	STATUS	1 = Valid Data
47	SIGN	1 = below
48		MSB = 8192 ft/min
49		
50		Interial Vertical Velocity
51		ARINC Label 365
52		
53		Range = [-16384, +16352]
54		
55		
56		LSB = 8192 / 256 = 32 ft/min

The status bits are determined as explained in §B.2.3.2. The data is rounded as specified in §B.2.3.2. The encoding accuracy of the data in the subfield is ±½ LSB by rounding.

"Barometric Altitude Rate" contains values that are solely derived from barometric measurement. The Barometric Altitude Rate may be very unsteady and may suffer from barometric instrument inertia.

The "Inertial Vertical Velocity" is also providing information on vertical attitude of the aircraft but it comes from equipments (IRS, AHRS) which use different sources used for navigation. The information is a more filtered and smoothed parameter.

Appendix C
Mode-S Specific Services (MSSS)

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C. Mode-S Specific Services (MSSS)

C.1 Introduction

C.1.1 Purpose

This Appendix sets forth minimum operational performance standards for the Mode S Specific Services (MSSS). The MSSS provides a standard communication interface and service through which avionics application processors may exchange data with ground based application processors via the Mode S transponder. Compliance with these standards is required to assure that the Mode S Specific Services characteristics will perform its intended functions satisfactorily under normal operating conditions. Incorporated within these standards are system characteristics that will facilitate the design and implementation of the Mode S Specific Services.

C.1.2 Scope

This Appendix defines the functional requirements for the Mode S Specific Services, and describes the architecture within which the Mode S Specific Services entity will operate. It does not define data link applications that will be supported by Mode S and other data links.

C.1.3 Mode-S Application Entity (AE) / Transponder Interface Management

The Mode S AE controls the interface to the Mode S Transponder based on information received from the Higher-Layer Entity (HLE) via the Specific Services Entity (SSE) interface, and based on the internal processing requirements of the AE. Additionally, the Mode S AE receives information via the AE/Transponder interface, which must be processed and transferred to the HLE.

The Mode S AE must also establish and maintain the local relationship between the Mode S Aircraft AE and the various Mode S Ground AEs with which it communicates.

Note: *In the framework of these Mode S Specific Services referenced herein, the Mode S AE supports the functionality required to support implementation of these capabilities. A Mode S ADLP, as defined in RTCA/DO-218B, would provide the Mode S AE functionality required, but in the context of this Appendix, it does not necessitate the need for full Mode S ADLP capabilities.*

C.2 Design Requirements

C.2.1 Basic Operations

The Mode S Specific Services shall offer the following types of services to the user.

a. Mode S Protocol service: The Mode S Protocol (MSP) service transfers limited data between air and ground application peers, using extremely low overhead. The MSP service does not use diagnostic, flow control, or interrupt procedures as defined within ISO 8208. Such mechanisms should be defined within the application entities.

b. Broadcast Protocol service (Comm-A, Comm-B): The Mode S subnetwork is capable of supporting information delivery to all interrogators participating in data link operations for that aircraft through the use of the Broadcast Comm-B protocol. It is also able to receive messages directed to all transponders through the use of the Broadcast Comm-A protocol.

c. Ground Initiated Comm-B service: The Mode S subnetwork allows for the access of prestored data within the Mode S transponder (256 register set) from ground application entities.

C.2.2 Mode-S Specific Services Entity (SSE) Interface Requirements

C.2.2.1 General

The AE shall support the accessing of Mode S specific services through the provision of one or more separate AE interfaces.

Note: *Mode S specific services consist of the broadcast Comm-A and Comm-B, Ground Initiated Comm-B (GICB) and MSP.*

C.2.2.2 Functional Capability

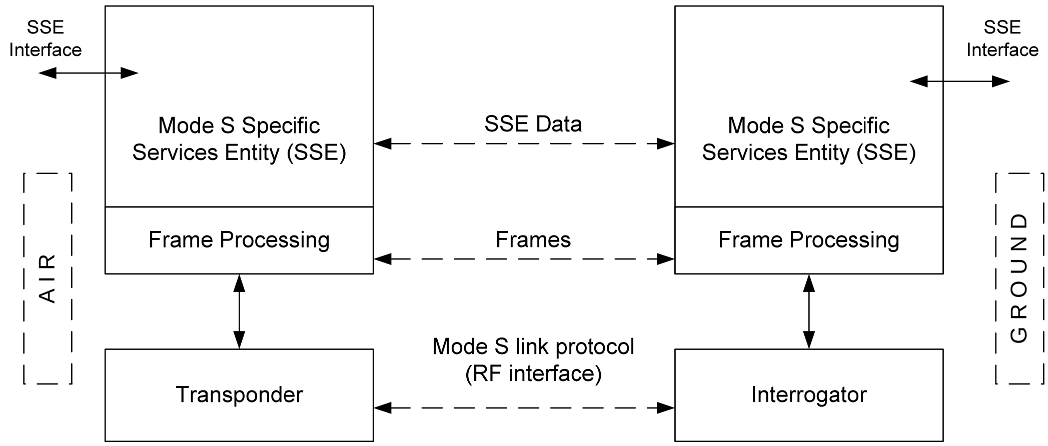
The AE shall support the accessing of Mode S specific services through the provision of one or more separate AE interfaces.

Message and control coding via the MSSS interface shall support all of the capabilities specified in §B.2.2.6.

Note: *Mode S specific services consist of the broadcast Comm-A and Comm-B, Ground Initiated Comm-B (GICB) and MSP.*

C.2.2.3 Mode-S Specific Services Architecture

The Mode S Specific Services architecture, as shown in Figure B-2-1, providces for the top level architecture, which is inclusive of the Mode S Specific Services Entity (SSE), the SSE interface to a higher layer application process, frame processing function, Mode S transponder (aircraft component), and Mode S interrogator (ground component). Between air and ground, the peer interface entities are identified as being, SSE Data, Frames, and Mode S link protocol (RF).



<u>Figure B-2-1:</u> Mode-S Specific Services Architecture

C.2.2.4 Transponder to Application Entity (AE) Interface

The AE shall accept an indication of protocol type from the transponder in connection with data transferred from the transponder to the AE. This shall include the following types of protocols:

a. Surveillance interrogation,

b. Comm-A interrogation,

c. Comm-A broadcast interrogation,

d. Uplink ELM.

The AE shall also accept the II code of the interrogator used to transmit the surveillance, Comm-A or uplink ELM.

<u>Note:</u> *Transponders will not output all call and Traffic Alert and Collision Avoidance System (TCAS) information on this interface. Use of SI code limited to Comm-A and Comm-A broadcast interrogations.*

The AE shall accept control information from the transponder indicating the status of downlink transfers. This shall include:

a. Comm-B closeout,

b. Comm-B broadcast time out,

c. Downlink ELM closeout.

The AE shall have access to current information defining the communication capability of the Mode S transponder with which it is operating. This information shall be used to generate the Data Link Capability Report.

C.2.2.5 Application Entity (AE) to Transponder Interface

The AE shall provide an indication of protocol type to the transponder in connection with data transferred from the AE to the transponder. This shall include the following types of protocols:

a. Ground initiated Comm-B,

b. Air initiated Comm-B,

c. Multisite directed Comm-B,

d. Comm-B broadcast,

e. Downlink ELM,

f. Multisite directed downlink ELM.

The AE shall also provide:

1. The II code for transfer of a multisite directed Comm-B or multisite directed downlink ELM, and

2. The Comm-B Data Selector (BDS) code for a ground initiated Comm-B.

Note: *Use of SI code limited to Ground-initiated Comm-B and Comm-B Broadcast.*

C.2.2.6 Mode-S Specific Services Processing

Mode S specific services shall be processed by an entity in the application termed the Mode S specific services entity.

C.2.2.6.1 Processing

Notes:

1. *There are three Mode S specific services protocol types; broadcast, GICB and MSP.*

2. *Control data can consist of information permitting message length, BDS code used to access the data format for a particular register, and aircraft 24 bit address.*

C.2.2.6.1.1 Downlink Processing

Note: *This section describes the processing of control and message data received from the Mode S specific services interface.*

C.2.2.6.1.1.1 General

The AE shall be capable of receiving control and message data from the Mode S specific services interface(s) and sending delivery notices to this interface. The control data shall be processed to determine the protocol type and the length of the message data. When a message or control data provided at this interface are erroneous (i.e., incomplete, invalid or inconsistent) the AE shall discard the message and deliver an error report at the interface.

Note: *The diagnostic content and the error reporting mechanism are a local issue.*

C.2.2.6.1.1.2 Broadcast Processing

The control and message data shall be used to format the Comm-B broadcast message as specified in §B.2.2.6.4 and transfer it to the transponder.

C.2.2.6.1.1.3 Ground-Initiated Comm-B (GICB) Processing

The 8 bit BDS code shall be determined from the control data. The 7 byte register content shall be extracted from the received message data. The register content shall be transferred to the transponder, along with an indication of the specified register number. A request to address one of the air initiated Comm-B registers or the TCAS Active Resolution Advisories Register shall be discarded.

The assignment of registers shall be as specified in Appendix B.

C.2.2.6.1.1.4 MSP Processing

The MSP message length, channel number (M/CH, §B.2.2.6.2.1) and optionally the interrogator II code shall be determined from the control data. The MSP message content shall be extracted from the received message data. If the message length is 26 bytes or less, the SSE shall format an air initiated Comm-B message for transfer to the transponder using the Short Form MSP Packet (see §B.2.2.6.2.1). If the message length is 27 to 159 bytes and the transponder has adequate downlink ELM capability, the SSE shall format an ELM message for transfer using the Short Form MSP Packet. If the message length is 27 to 159 bytes and the transponder has a limited downlink ELM capability, the SSE shall format multiple Long Form MSP Packets (see §B.2.2.6.2.2) using ELM messages as required utilizing the L bit and the M/SN Fields for association of the packets. If the message length is 27 to 159 bytes and the transponder does not have downlink ELM capability, the SSE shall format multiple long form MSP packets using air initiated Comm-B messages, as required utilizing the L bit and M/SN fields for association of the packets. Different frame types shall never be used in the delivery of an MSP message. Messages longer than 159 bytes shall be discarded. The assignment of downlink MSP channel numbers shall be as specified in Table B-2 2.

For an MSP, a request to send a packet shall cause the packet to be multisite-directed to the interrogator II code as specified in control data. If no II code is specified, the packet shall be down linked using the air-initiated protocol. A message delivery notice for this packet shall be provided to the Mode S specific interface when the corresponding closeout(s) have been received from the transponder. If a closeout has not been received from the transponder in Tz seconds, as specified in Table B-2-2, the MSP packet shall be discarded. This shall include the cancellation in the transponder of any frames associated with this packet. A delivery failure notice for this message shall be provided to the Mode S specific services interface.

Table B-2-2: MSP Channel Number Assignments

Uplink Channel Number	Assignment
0	Not Valid
1	Specific Services Management
2	Traffic Information Service
3	Ground-to-Air Alert
4	Ground Derived Position
5	TCAS Sensitivity Level Control
6	Ground-to-Air Service Request
7	Air-to-Ground Service Response
8 – 63	Unassigned

Downlink Channel Number	Assignment
0	Not Valid
1	Specific Services Management
2	Unassigned
3	Data Flash
4	Position Request
5	Unassigned
6	Ground-to-Air Service Response
7	Air-to-Ground Service Request
8 – 63	Unassigned

Table B-2-3: Broadcast Identifier Number Assignments

Uplink Broadcast Identifier	Assignment
00_{16}	Not Valid
01_{16}	Differential GPS Correwction
30_{16}	Not Valid
31_{16}	TCAS/ACAS (RA Broadcast)
32_{16}	TCAS/ACAS (ACAS Broadcast)
Others	Unassigned

Downlink Broadcast Identifier	Assignment
00_{16}	Not Valid
02_{16}	Traffic Information Service
10_{16}	Data Link Capability Report
20_{16}	Aircraft Identification
30_{16}	TCAS/ACAS (RA Broadcast)
FE_{16}	Update Request
FF_{16}	Search Request
Others	Unassigned

C.2.2.6.1.2 Uplink Processing

Note: *This section describes the processing of Mode S specific services messages received from the transponder.*

C.2.2.6.1.2.1 General

The AE shall be capable of receiving Mode S specific services messages from the transponder via Frame Processing. The AE shall be capable of delivering the messages and the associated control data at the specific services interface. When the resources allocated at the interface are insufficient to accommodate the output data, the AE shall discard the message and deliver an error report at this interface.

C.2.2.6.1.2.2 Broadcast Processing

If the received message is a broadcast Comm-A, as indicated by control data received over the transponder/AE interface, the broadcast ID and user data (see §B.2.2.6.4) shall be forwarded to the Mode S specific services interface, along with the control data that identifies this as a broadcast message. The assignment of uplink broadcast identifier numbers shall be as specified in Table B-2-3.

C.2.2.6.1.2.3 MSP Processing

If the received message is an MSP, as indicated by the packet format header (see §B.2.2.6.2), the User Data Field of the received MSP packet shall be forwarded to the

Mode S specific services interface together with control data that identifies this as an MSP message. L bit processing (see §B.2.2.6.3) shall be performed as required. The assignment of uplink MSP channel numbers shall be as specified in Table B-2-3.

C.2.2.6.2 MSP Packet Formats

C.2.2.6.2.1 Short Form MSP Packet

The format for this packet shall be as follows:

DP:1	MP:1	M/CH:6	FILL 1:0 or 6	UD:v

Data Packet: Type (DP) This field shall be set to ZERO (0).

MSP Packet Type (MP): This field shall be set to ZERO (0) to indicate that this is a Short Form MSP Packet.

MSP Channel Number (M/CH): The field shall be set to the channel number derived from the SSE control data (Table B-2-5).

Fill Field. (FILL1: 0 or 6): The Fill length shall be 6 bits for a downlink SLM Frame. Otherwise the Fill length shall be ZERO (0).

User Data (UD): The User Data Field shall contain message data received from the Mode S specific services interface.

C.2.2.6.2.2 Long Form MSP Packet

The format for this packet shall be as follows:

DP:1	MP:1	SP:2	L:1	M/SN:3	FILL 2:0 or 2	M/CH:6	UD:v

Data Packet Type (DP): This field shall be set to ZERO (0).

MSP Packet Type (MP): This field shall be set to ONE (1) to indicate that this is not a Short Form MSP Packet.

Supervisory Packet (SP): This field shall be set to ZERO (0).

L Field (L): A value of one shall indicate that the packet is part of an L bit sequence with more packets in the sequence to follow. A value of ZERO (0) shall indicate that the sequence ends with this packet.

MSP Sequence Number Field (M/SN): This field shall be used to detect duplication in the delivery of L bit sequences. The first packet in an L bit sequence shall be assigned a sequence number of ZERO (0). Subsequent packets shall be numbered sequentially. A packet received with the same sequence number as the previously received packet shall be discarded.

MSP Channel Number (M/CH): The field shall be set to the channel number derived from the SSE control data (Table B-2-5).

User Data (UD): The User Data Field shall contain message data received from the Mode S specific services interface.

C.2.2.6.3 L-Bit Processing

L bit processing shall be performed only on the Long Form MSP Packet.

Upon receipt of a long form MSP Packet the AE shall construct the User Data Field by:

a. Verifying that the packet order is correct using the M/SN Field (see §B.2.2.6.2.2).

b. Assuming that the User Data Field in the MSP Packet is the largest number of integral bytes that is contained within the frame.

c. Associating each User Data Field in an MSP Packet received with a previous User Data Field in an MSP Packet that has an L bit value of ONE (1).

d. Truncating the assembled User Data Field to 151 bytes if necessary.

Note: *Truncation of the user data field is a condition that cannot be reported.*

e. If an error is detected in the processing of an MSP packet, the packet shall be discarded.

In the processing of an L bit sequence, the AE shall discard any MSP packets that have duplicate M/SN values. The AE shall discard the entire L bit sequence if a long form MSP Packet is determined to be missing by use of the M/SN Field.

The packets associated with any L bit sequence whose reassembly is not completed in Tm seconds (Table B-2 4) shall be discarded.

C.2.2.6.4 Broadcast Format

The first byte of the broadcast MA field shall contain the broadcast identifier as specified in Table B-2-1.

C.2.2.7 Frame Processing

C.2.2.7.1 Uplink Frames

C.2.2.7.1.1 Uplink SLM Frames

An uplink SLM frame shall be composed of up to 4 selectively addressed Comm-A segments.

Note: *Each Comm-A segment (MA Field) received by the AE is accompanied by the first 32 bits of the interrogation that delivered the segment. Within these 32 bits is the 16 bit Special Designator (SD) Field.*

C.2.2.7.1.1.1 SD Field

When the Designator Identification (DI) Field (bits 14 16) has a code value of 1 or 7, the Special Designator (SD) Field (bits 17 32) of each Comm-A interrogation shall be used to obtain the Interrogator Identifier Subfield (IIS, bits 17 20) and the Linked Comm-A Subfield (LAS, bits 30 32). The action to be taken shall depend on the value of LAS. The contents of LAS and IIS shall be retained and shall be associated with the Comm-A message segment for use in assembling the frame as indicated below. All fields other than the LAS Field shall be as defined in DO-181C (Ref. 3).

SD FIELD

For DI=1

					➔	**TMS**
ILS	**MBS**	**MES**	**LOS**	**RSS**	**SPARE**	**LAS**
17 ➔ 20	21 ➔ 22	23 ➔ 25	26	27 ➔ 28	29	30 ➔ 32

For DI=7

					➔	**TMS**
ILS	**RRS**	**SPARE**	**LOS**	**SPARE**	**SPARE**	**LAS**
17 ➔ 20	21 ➔ 24	25	26	27 ➔ 28	29	30 ➔ 32

Figure B-2-2: The SD Field Structure

C.2.2.7.1.1.2 LAS Coding

The three bit LAS subfield shall be coded as specified in Table B-2-4.

<u>Table B-2-4:</u> LAS Subfield Coding

LAS (decimal)	**Meaning**
0	Single segment
1	Linked, 1st segment
2	Linked, 2nd but not final segment
3	Linked, 3rd but not final segment
4	Linked, 4th and final segment
5	Linked, 2nd and final segment
6	Linked, 3rd and final segment
7	Unassigned

C.2.2.7.1.1.3 Single Segment SLM Frame

If LAS=0, the data in the MA Field shall be considered a complete frame and shall be made available for further processing.

C.2.2.7.1.1.4 Multiple Segment SLM Frame

The AE shall accept and assemble linked 56 bit Comm-A segments associated with all 16 possible Interrogator Identifier (II) codes. Correct linking of Comm-A segments shall be achieved by requiring that all Comm-A segments have the same value of IIS. If LAS=1 through 6 the frame shall consist of two to four Comm-A segments as specified in the following:

<u>Note 1:</u> *The number of linked Comm-A's is limited to four because longer linked Comm-A transmissions would result in inefficient utilization of the Mode S link, as well as slow frame delivery. Longer frames can be transferred more efficiently using the ELM protocol.*

<u>Initial Segment:</u> If LAS = 1, the MA Field shall be assembled as the initial segment of an SLM frame. In this case, the initial segment shall be stored until all segments of the frame have been received or the frame is canceled.

<u>Intermediate Segment:</u> If LAS = 2 or 3, the MA Field shall be assembled in numerical order as an intermediate segment of the SLM frame. It shall be associated with previous segments containing the same value of IIS.

<u>Final Segment:</u> If LAS = 4, 5 or 6, the MA Field shall be assembled as the final segment of the SLM frame. It shall be associated with previous segments containing the same value of IIS.

<u>Note 2:</u> *A two segment linked Comm-A will consist of an initial segment (LAS=1) and a final segment (LAS=5).*

Frame Completion: The frame shall be considered complete and shall be made available for further processing as soon as all segments of the frame have been received.

Frame Cancellation: An incomplete SLM frame shall be canceled if one or more of the following conditions apply:

a. A new initial segment (LAS=1) is received with the same value of IIS. In this case, the new initial segment shall be retained as the initial segment of a new SLM frame.

b. The sequence of received LAS codes (after the elimination of duplicates) is not contained in the following list:

    1. LAS = 0
    2. LAS = 1,5
    3. LAS = 1,2,6
    4. LAS = 1,6,2
    5. LAS = 1,2,3,4
    6. LAS = 1,3,2,4
    7. LAS = 1,2,4,3
    8. LAS = 1,3,4,2
    9. LAS = 1,4,2,3
    10. LAS = 1,4,3,2

c. Tc (seconds) have elapsed since the last Comm-A segment with the same value of US was received. See Table 2-8.

Segment Cancellation

A received segment for an SLM frame shall be discarded if it is an intermediate or final segment and no initial segment has been received with the same value of IIS.

Segment Duplication

If a received segment duplicates a currently received segment number with the same value of IIS, the new segment shall replace the currently received segment.

Note 3: *The action of the Mode S link protocols may result in the duplicate delivery of Comm-A segments.*

C.2.2.7.1.2 Uplink ELM Frame

An uplink ELM frame shall consist of from 20 to 160 bytes and shall be transferred from the interrogator to the transponder using the protocol defined in DO-181C (Ref. 3). The first 4 bits of each uplink ELM segment (MC Field) shall contain the Interrogator Identifier (II) code of the Mode S interrogator transmitting the ELM. The AE shall check the II code of each segment of a completed uplink ELM. If all of the segments contain the same II code, the II code in each segment shall be deleted and the remaining message bits retained as user data for further processing. If all of the segments do not contain the same II code, the entire uplink ELM shall be discarded.

Note: *An uplink ELM frame consists of 2 to 16 associated Comm C segments, each of which contains the 4 bit II code. Therefore, the capacity for packet transfer is 19 to 152 bytes per uplink ELM frame.*

C.2.2.7.2 Downlink Frames

Note: *Data is transferred from an AE to a "Ground Application Entity" using downlink frames.*

C.2.2.7.2.1 Downlink SLM Frame

A downlink SLM frame shall be composed of up to 4 Comm-B segments. The MB Field of the first Comm-B segment of the frame shall contain a 2 bit Linked Comm-B Subfield (LBS, bit 1 and 2 of the MB Field). This subfield shall be used to control linking of up to 4 Comm-B segments.

Note: *The LBS uses the first two bit positions in the first segment of a multi or single segment downlink SLM frame. Hence, 54 bits are available for Mode S packet data in the first segment of a downlink SLM frame. The remaining segments of the downlink SLM frame, if any, have 56 bits available.*

C.2.2.7.2.1.1 LBS Coding

Linking shall be indicated by the coding of the LBS subfield of the MB Field of the initial Comm-B segment of the SLM frame.

The coding of LBS shall be as specified in Table B-2-5.

Table B-2-5: LBS Subfield Coding

LBS (decimal)	**Meaning**
0	Single segment
1	Initial segment of a two-segment SLM frame
2	Initial segment of a three-segment SLM frame
3	Initial segment of a four-segment SLM frame

C.2.2.7.2.1.2 Linking Protocol

In the Comm-B protocol, the initial segment shall be transmitted using the air initiated or multisite directed protocols. The LBS Field of the initial segment shall indicate to the ground the number of additional segments to be transferred (if any). Before the transfer of the initial segment to the transponder, the remaining segments of the SLM frame (if any) shall be transferred to the transponder for transmission to the interrogator using the ground initiated Comm-B protocol. These segments shall be accompanied by control codes that cause the segments to be inserted in ground initiated Comm-B Registers 02_{16}, 03_{16} or 04_{16}, associated respectively with the second, third, or fourth segment of the frame.

Closeout of the air initiated segment that initiated the protocol shall not be performed until all segments have been successfully transferred.

Notes:

1. *The linking procedure including the use of the ground initiated Comm-B protocol is performed by the AE.*

2. *When the Mode S interrogator detects a non-zero LBS code in an air initiated or multisite directed Comm-B segment, it can proceed immediately with the ground initiated Comm-B protocol and request the remaining segments of the SLM frame. When it has received all of the segments, it closes out the air initiated or multisite directed segment that began the linked Comm-B protocol.*

3. *This linking protocol, as well as the linked Comm-A protocol, is transparent to the transponder.*

C.2.2.7.2.1.3 Directing SLM Frames

If the SLM frame is to be multisite directed, the AE shall determine the II code of the Mode S interrogator or cluster of interrogators (see §2.2.7.1.3) that shall receive the SLM frame.

C.2.2.7.2.2 Downlink ELM Frame

Downlink ELM frames shall be used to deliver messages greater than 128 bytes and shall be formed using the protocol defined in DO-181C.

Note: *A downlink ELM consists of 1 to 16 associated Comm D segments.*

C.2.2.7.2.2.1 Directing ELM Frames

If the ELM frame is to be multi-site directed, the AE shall determine the II code of the Mode S interrogator or cluster of interrogators (see §2.2.7.1.3) that shall receive the ELM frame.

C.2.2.7.2.3 Delivery Status

AE Frame Processing shall accept an indication from the transponder that a specified downlink frame that was previously transferred to the transponder has been closed out as specified in DO-181C (Ref. 3).

C.2.2.7.2.4 Interrogator Identifier

AE Frame Processing shall accept from the transponder, along with the data in each uplink SLM or ELM, the Interrogator Identifier (II) code of the interrogator that transmitted the frame. AE Frame Processing shall transfer to the transponder the II code of the interrogator or cluster of interrogators that shall receive a multi-site directed frame.

C.2.2.7.2.5 Frame Cancellation

AE Frame Processing shall be capable of canceling downlink frames previously transferred to the transponder for transmission but for which a closeout has not been indicated. If more than one frame is stored within the transponder, the cancellation procedure shall be capable of canceling the stored frames selectively.

Note: *Comm-B segments) minus the 2 bit Linked Comm-B Subfield (see §2.2.5.2. 1.1).*

C.2.2.8 System Timers

The values for timers referenced in this specification shall conform to the values given in Table B-2-6.

Table B-2-6: AE Mode-S Subnetwork Timers

Timer Name	Timer Label	Nominal Value	Reference
L-Bit Delivery	Tm	120 seconds	§B.2.2.6.3
Interrogator Link	Tz	30 seconds	§B.2.2.6.1.1.4
Link Frame Cancellation	Tc	60 seconds	§B.2.2.5.1.1.4

Tolerance for all timers shall be ±1 percent.
Resolution for all timers shall be 1 second.

C.3 Mode-S Specific Services Test Procedures

The test procedures set forth below constitute a satisfactory method of determining required Mode S Specific Services performance. Although specific test procedures are cited, it is recognized that other methods may be preferred. Such alternate methods may be used if the manufacturer can show that they provide at least equivalent information. Therefore, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternate procedures.

C.3.1 General Characteristics

The test configuration (Figure B-4-1) provides a means of validating the information content of any message received from the Aircraft Application Entity (AAE), as well as the Ground Application Entity (GAE), which is processed and managed by both the Aircraft – Specific Services Entity (A-SSE), and the Ground – Specific Services Entity (G-SSE).

The test configuration should be capable of generating or accepting messages in the form of MSPs, Broadcast and GICB. The test configuration should be able to format and populate the data content for MSSS type messages.

The test configuration should be capable of generating the entire content of a Long and Short Mode S uplink message, and accept the entire content of a Long and Short downlink message according to the following:

(1) Long Mode S messages are 112 bits, encoded per RTCA/DO 181C (Ref. 3), §2.2.14 and §2.2.17. Short Mode S messages are 56 bits, also coded according to RTCA/DO-181C (Ref. 3), §2.2.14 and §2.2.17. When required, the coding of these messages is contained in the appropriate test procedure of this Appendix.

(2) For uplink Extended Length Messages (ELM)s, the test configuration should be able to convey a control field called Interrogator Identification Subfield (IIS) to the A-SSE independently of the messages described in (1) above.

(3) The test configuration should be able to convey delivery status of Mode S downlink messages to the A-SSE independently of the messages described in (1) above.

(4) The test configuration should be able to accept from the A-SSE a Mode S frame cancellation message independently of the messages described in (1) above.

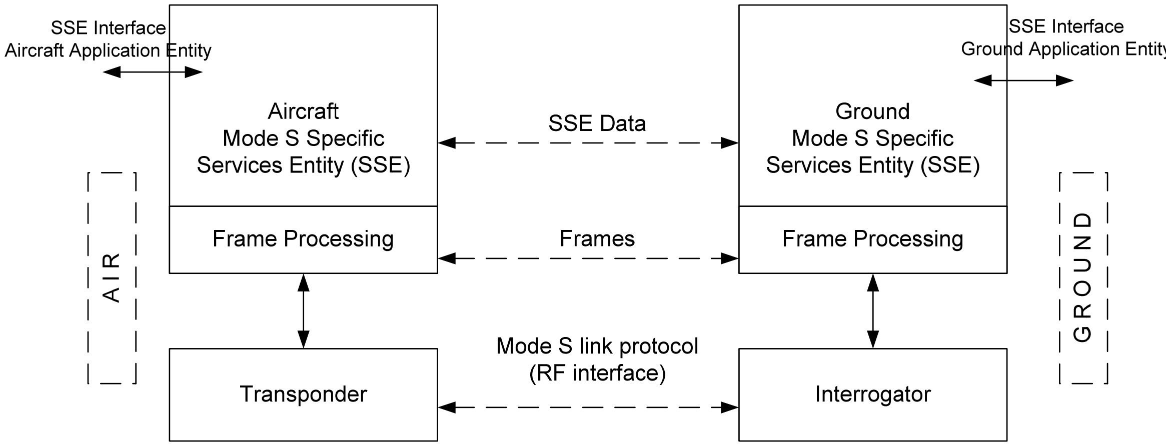


Figure B-4-1: **Mode-S Specific Services Test Configuration**

C.3.2 Detailed Test Procedures

C.3.2.1 Downlink Processing

C.3.2.1.1 Broadcast Processing

(§C.2.2.6.1.1.1 – General)
(§C.2.2.6.1.1.2 – Broadcast Processing)
(§C.2.2.6.4 – Broadcast Format)

Objective: This test is designed to validate the downlink broadcasting function of the MSSS, which includes broadcast processing and formatting of the broadcast messages.

Step 1 Generate two 56 bit downlink broadcast messages. The 56-bit message data field will consist of an alternating one zero pattern and alternating zero one pattern for alternate packets. Send the two broadcast messages to the A-SSE.

Step 2 At the G-SSE, verify that the transponder has generated two broadcast Comm-B segments whose MB Fields are equal to the message data fields of the broadcast messages. Verify format and content of the broadcast message.

Step 3 Generate a downlink broadcast message from the A-SSE with the data field length greater than 56 bits.

Step 4 Verify that an error message to the A-SSE is generated, and that no request for a Comm-B downlink appears at the RF interface.

C.3.2.1.2 MSP Processing

(§C.2.2.6.1.1.4 – MSP Processing)
(§C.2.2.6.2.1 – Short Form MSP Packet)
(§C.2.2.6.2.2 – Long Form MSP Packet)
(§C.2.2.7.2.3 – Delivery Status)

Objective: This test is designed to validate the downlink MSP processing function of the MSSS, which includes MSP processing, delivery status and formatting of the short form and long form MSP packets. The tests cover both SLM and ELM capabilities of the Mode S Transponder.

SLM Capable

Step 1 Uniquely identify the UD fields of each MSP packet by using recognizable sequences of bit and/or byte patterns. One method for uniquely identifying each packet for this test is to insert the MSP channel number in the UD Field.

Step 2 From the AAE, generate the following MSP packets:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	8	5 bytes	1 segment	48 – 41
b.	4	12 bytes	2 segments	52 – 49
c.	4	19 bytes	3 segments	56 – 53
d.	4	26 bytes	4 segments	60 – 57
e.	3	29 bytes	See text	63 – 61
f.		165 bytes		61

Step 3 For groups "a" through "d," extract all Comm-B segments, and follow each with a closeout, as necessary. Verify that the control codes are DP=0, MP=0 (indicating the Short form MSP) and M/CH field corresponds to the selected MSP packet group (M/CH=48 to 41 for group a., M/CH = 52 to 49 for group b., etc.). Verify that the status of each downlink is sent to the A-SSE.

Note: *The packet from group e is oversize and cannot be transmitted in entirety. This portion of the test requires the A-SSE to use Long Form MSP packets with L bit assembly.*

Step 4 Verify that the first Comm-B message contains 26 bytes of user data identical to the first 26 bytes of the UD Field in the original MSP message, and the L bit is set. Verify that the second Comm-B message contains one segment with the MB Field identical to the last three bytes of user data in the original MSP message, and the L bit is not set.

Step 5 Send the data from group f to the A-SSE. Verify that no request for Comm-B downlink appears at the A-SSE RF interface.

ELM Capable

Step 1 Repeat the group e test described in the previous paragraph with the condition that the oversize packets are to be sent in total using downlink ELM containing Short MSP packets.

C.3.2.2 Uplink Processing

C.3.2.2.1 Broadcast Processing

(§C.2.2.6.1.2.1 – General)
(§C.2.2.6.1.2.2 – Broadcast Processing)
(§C.2.2.6.4 – Broadcast Format)
(§C.2.2.7.2.4 – Interrogator Identifier)

Objective: This test is designed to validate the uplink broadcasting function of the MSSS, which includes broadcast processing, interrogator identifier, and formatting of the broadcast messages.

Step 1 Send twelve uplink Comm-A Broadcast messages divided into two groups of six interrogations. The first group will be uplinked with a UF Field = 20 and the second group with UF = 21. Within each group of six interrogations, the 56 bit MA fields will contain a combination of the following bit patterns: all ones, all zeros, alternating ones and zeros and alternating zeros and ones. For each frame, set DI = 1 or 7, IIS = 15, and SD (except IIS) = 0, and provide an indication that the frame is an unlinked Comm-A (LAS = 0).

Step 2 Verify that the data delivered to the A-SSE interface contains the 56 bits of data in the MA field, the 32 bits Mode S frame header information, the II code, the broadcast ID and an indication that the frames are Comm-A broadcast frames."

C.3.2.2.2 MSP Processing

(§C.2.2.6.1.2.3 – MSP Processing)
(§C.2.2.6.2.1 – Short Form MSP Packet)
(§C.2.2.6.2.2 – Long Form MSP Packet)

Objective: This test is designed to validate the uplink MSP processing function of the MSSS, which includes MSP processing and formatting of the short form and long form MSP packets. The tests cover both SLM and ELM capabilities of the Mode S Transponder. The test uplinks several packets on different Mode S MSP channel numbers. The A-SSE is required to reformat Short and Long MSP packets into message and control data for the AE Separate Interface.

Step 1 Uniquely identify the UD fields of each MSP packet by using recognizable sequences of bit and/or byte patterns. One method for uniquely identifying each packet for this test is to insert the MSP channel number in the UD Field.

Step 2 Send the following MSP messages to the AAE from the G-SSE interface:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	8	6 bytes	1 segment	48 – 41
b.	4	13 bytes	2 segments	52 – 49
c.	4	20 bytes	3 segments	56 – 53
d.	4	27 bytes	4 segments	60 – 57
e.	3	29 bytes	See text	63 – 61

Step 3 Verify that the A-SSE forwards the contents of the UD fields, as well as a means for identifying the packets as MSP data, to the AAE interface.

Step 4 In case e), send to the A-SSE 2 Mode S linked Comm-A frames containing 2 linked Mode S Long Form MSP Packet on the selected MSP channel number. The first packet will have L bit set to one and contain 26 bytes of user data. The second frame will have L bit set to zero and contain 3 bytes of user data. Make sure the A-SSE forwards the contents of the UD Field in its entirety and correct order to the AAE.

Step 5 If ELM capability is available, repeat Step e) but this time send a Mode S Short Form MSP packet to the A-SSE containing 29 bytes of data in the UD Field. Verify that the A-SSE forwards the contents of the UD Field as a means for identifying the packet as MSP data, to the AAE.

C.3.2.3 Frame Tests

C.3.2.3.1 Uplink SLM Frames

(§C.2.2.7.1.1 – Uplink SLM Frame)
(§C.2.2.7.1.1.1 – SD Field)
(§C.2.2.7.1.1.2 – LAS Coding)
(§C.2.2.7.1.1.3 – Single Segment SLM Frame)
(§C.2.2.7.1.1.4 – Multiple Segment SLM Frame)
(§C.2.2.7.2.5 – Frame Cancellation)

Objective: This test is designed to validate the uplink frame function of the MSSS, which includes processing of the SLM frame, SD field, LAS coding, the frame cancellation function, and the management of single segment and multiple segment SLM frames.

Single Segment SLM Frame

Step 1 From the G-SSE interface, generate 4 unlinked Comm-A frames containing Mode S Short Form MSP Packets having uniquely identifiable data in each of the 6 byte UD fields.

Step 2 Send this data to the A-SSE using MSP Channel Number 48 for the first frame, 47 for the second frames, etc., and use II = 6 for all frames.

Step 3 Verify that the A-SSE accepts control and message data from the transponder interface indicating 4 unlinked Comm-A segments with IIS = 6 and LAS = 0 in each case. Also, Verify also that the A-SSE forwards the content of the UD Field to the A-SSE interface as well as a means for identifying the packets as MSP data, to the A-SSE interface.

Note: *If this test is to be performed in conjunction with Mode S transponder validation, the message field must be duplicated exactly in the Mode S RF interrogation, and uplink formats 20 and 21 must both be used.*

SD Field
LAS Coding
Frame Cancellation
Multiple Segment SLM Frame

This test requires the transmission of linked Comm-A segments over MSP channels.

In order for the A-SSE to reformat the frames, it is necessary to have segment number one contain the Short Form MSP Packet header.

Linked Comm-A messages can be canceled either whole or in part if the segments are not correctly received as determined by the LAS Field.

Step 1 Generate the following table of uplink frame data. Uniquely identify the data in the MA fields of each segment by using recognizable sequences of bit and/or byte patterns. All segments should be delivered by the same sensor II code, that is sensor 1, except frames 13 and 15 which should be delivered by sensor number 2.

Step 2 Send the following sequence of frames to the A-SSE:

LAS CODING

Frame	1	2	3	4	5	6	Notes
1.	1	0	0	0	1	0	Initial and Final Segments
2.	0	1	1	1	0	0	Two intermediate and one final segment; no initial segment
3.	1	1	0	0	0	1	Initial intermediate and final segments
4.	1	1	1	0	0	0	Initial and intermediate segments; no final segment
5.	1	0	0	0	0	1	Initial, third/final segments, no second segment
6.	1	1	1	0	0	0	Initial and intermediates; no final segment
7.	0	0	0	0	0	0	Delay Tc Plus one second
8.	0	0	0	1	0	0	Final segment for frame 6
9.	1	1	1	0	0	0	Initial and intermediate segments
10.	0	0	1	1	0	0	Duplicate and final segment for frame 9
11.	1	1	1	1	0	0	All 4 segments complete
12.	1	0	0	0	0	0	Initial segment IIS=1
13.	1	0	0	0	0	0	Initial segment IIS=2
14.	0	0	0	0	1	0	Final segment IIS=1
15.	0	0	0	0	1	0	Final segment IIS=2
16.	1	0	0	0	0	1	First and final segment
17.	0	1	0	0	0	0	Second segment

Step 3 Send each frame at 10 second intervals, except frame 7. After sending frame 6, wait at least Tc plus one second before sending frame 8. Thereafter, continue with 10 second intervals.

Step 4 Verify that frames 1, 3, 11, 12/14, 13/15, and 16/17 are sent to the A-SSE interface. Verify the 0.25 second reformatting time requirement and the data content for completeness and proper order.

Step 5 Frames 9 and 10 should comprise a complete linked Comm-A. However, segment 3 is duplicated in frame 10 and should be discarded. Verify that frames 9 and 10 are sent to the A-SSE interface. Verify from the length and content that the duplicate segment has been discarded.

Step 6 Frames 2, 4, 5, 6 and 8 should all be discarded; no message data should result. Each of these frames meets one of the conditions of §2.2.5.1.1.4 for uplink frame cancellation.

<u>Link Frame Cancellation Timer Tc</u>

Step 1 Generate two Short Form MSP packets with a 27 byte UD Field to fit into a four segment linked Comm-A message. The content of the UD Field will be a 1 in the first byte, 2 in the second byte, etc. Set II = 1 for all segments.

Step 2 Send only the first three Comm-A segments of the first frame to the A-SSE. Impose a delay of Tc minus two seconds, then send the final segment.

Step 3 Verify that the A-SSE forwards to the AAE interface a MSP message with a 27 byte UD Field in correct order and content.

Step 4 Repeat the process just described and transmit the first three Comm-A segments of the second frame. However, this time impose a delay of Tc plus two seconds between the transmission of the third and the final Comm-A segments. Verify that there is no output to the AAE.

C.3.2.3.2 Uplink ELM Frames

(§C.2.2.7.1.2 – Uplink ELM Frame)

Objective: This test is designed to validate the uplink frame function of the MSSS, and is intended to demonstrate that the A-SSE can receive segments of an ELM. ELM protocol is strictly a transponder issue; the A-SSE has no part in the message handling until the transponder sends a complete ELM.

The data content of each of the segments of the ELM will be identical to the transponder MC Fields after the receipt of an ELM. The bit pattern contained in the MC Field should permit each segment's data to be uniquely identified. Note that the first four bits of each uplink ELM MC Field contains the II code of the sensor. Therefore, there are 76 bits of User Data in each uplink ELM segment. All segments should be delivered by the same sensor 1, code.

Step 1 Send the following table of ELM frames (UF = 24) containing the Short Form of MSP packets, to the A-SSE at the transponder interface:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	1	18 bytes	2 segments	2
b.	1	27 bytes	3 segments	3
c.	1	37 bytes	4 segments	4
d.	1	46 bytes	5 segments	5
e.	1	56 bytes	6 segments	6
f.	1	65 bytes	7 segments	7
g.	1	75 bytes	8 segments	8
h.	1	84 bytes	9 segments	9
i.	1	94 bytes	10 segments	10
j.	1	103 bytes	11 segments	11
k.	1	113 bytes	12 segments	12
l.	1	122 bytes	13 segments	13
m.	1	132 bytes	14 segments	14
n.	1	141 bytes	15 segments	15
o.	1	151 bytes	16 segments	16

Step 2 Verify also that the A-SSE forwards the contents of the UD fields of the MSP packets and a means for identifying the packet as MSP data, to the AAE interface.

Negative Uplink ELM Frame Test

The A-SSE must discard the entire uplink ELM if all of the segments do not contain the same II code.

Step 1 Repeat the previous test with data from group “a” of the test but send the last segment with an II code different from the II code contained in the first segment.

Step 2 Verify that no output is generated to the A-SSE.

C.3.2.3.3 Downlink SLM Frames

(§C.2.2.7.2.1 – Downlink SLM Frame)
(§C.2.2.7.2.1.1 – LBS Coding)
(§C.2.2.7.2.1.2 – Linking Protocol)
(§C.2.2.7.2.1.3 – Directing SLM Frames)
(§C.2.2.7.2.3 – Delivery Status)

Objective: This test is designed to validate the downlink frame function of the MSSS, which includes processing of the SLM frame, LBS coding, linking protocol, directing and delivery status of SLM frames. This test requires the transmission single and linked Comm-B segments over MSP channels.

SLM Capable

Step 1 Uniquely identify the UD fields of each MSP packet by using recognizable sequences of bit and/or byte patterns. One method for uniquely identifying each packet for this test is to insert the MSP channel number in the UD Field. Set II=1 for all packets in this section.

Step 2 Send the following MSP messages to the A-SSE from the AAE interface:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	8	5 bytes	1 segment	48 – 41
b.	4	12 bytes	2 segments	52 – 49
c.	4	19 bytes	3 segments	56 – 53
d.	4	26 bytes	4 segments	60 – 57
e.	3	29 bytes	See text	63 – 61

Step 3 Extract each Comm-B segments from the A-SSE and send Comm-D close-outs, as necessary. Verify the A-SSE sends an indication of the downlink delivery status to the AAE. Verify the correct association of LBS value with the number of segments delivered and that the M/CH field decrements correctly.

Note: *Since the transponder is not downlink ELM capable, the packets from group "e" will be sent via Comm-B segments with MSP L bit procedures.*

Step 4 Verify that the first Comm-B message from group e consists of 4 segments and contains 26 bytes of data in the MB Field(s) and that the second Comm-B message contains one segment with three bytes of data in the MB Field.

C.3.2.3.4 Downlink ELM Frame

(§C.2.2.7.2.2 – Downlink ELM Frame)
(§C.2.2.7.2.2.1 – Directing ELM Frame)

Objective: This test is designed to validate the downlink frame function of the MSSS, which includes processing of the ELM frames. This test requires the transmission of ELM segments over MSP channels.

ELM Capable

Step 1 Uniquely identify the UD fields of each MSP packet by using recognizable sequences of bit and/or byte patterns. One method for uniquely identifying each packet for this test is to insert the MSP channel number in the UD Field.

Step 2 Send the following MSP messages to the A-SSE from the AAE interface:

Group	# of Packets	UD Field Length	Packet Size	MSP Channel Numbers
a.	1	9 bytes	1 segment	1
b.	1	19 bytes	2 segments	2
c.	1	29 bytes	3 segments	3
d.	1	39 bytes	4 segments	4
e.	1	49 bytes	5 segments	5
f.	1	59 bytes	6 segments	6
g.	1	69 bytes	7 segments	7
h.	1	79 bytes	8 segments	8
i.	1	89 bytes	9 segments	9
j.	1	99 bytes	10 segments	10
k.	1	109 bytes	11 segments	11
l.	1	119 bytes	12 segments	12
m.	1	129 bytes	13 segments	13
n.	1	139 bytes	14 segments	14
o.	1	149 bytes	15 segments	15
p.	1	159 bytes	16 segments	16

Step 3 Extract the Comm-D segments from the A-SSE and send Comm-D close-outs, as necessary. Verify the A-SSE sends an indication of the downlink delivery status to the AAE interface. At the GAE interface, verify the correct association of the ND value with the number of segments delivered and that the M/CH field increments correctly for each packet.

C.3.2.4 MSP Operations

(§C.2.2.6.1.1.4, §C.2.2.6.1.2.3 – MSP Processing)
(§C.2.2.6.3 – L-bit Processing)
(§C.2.2.8 – System Timers)

Objective: This test is designed to validate the MSP operations by using L-bit linking, MSP processing and System Timers in associated with these operations.

Step 1 Send 4 bytes of CONTROL MESSAGE data from the AAE interface on channel 1. Verify at the G-SSE interface that the A-SSE has sent a Mode S short form MSP packet on channel 1.

Step 2 Send 42 bytes of CONTROL MESSAGE DATA from the AAE interface on channel 1. At the G-SSE, verify that two Mode S MSP packets (long form) are received from the A-SSE on channel 1. The first frame will have L bit set to one and contain 26 bytes of user data. The second frame will have L bit set to zero and contain 16 bytes of user data.

Step 3 Send a Mode S frame containing a Mode S MSP (short form) Packet to the A-SSE on channel 2. Fill the UD Field with five bytes of the bit pattern 01010101. At the A-SSE interface, verify the reception of a CONTROL MESSAGE DATA on channel 2.

Step 4 Generate 42 bytes of Control Message Data from the G-SSE interface on MSP channel 1 in a total of 2 MSP packets (Long Form). The first MSP packet will have L-bit set to 1 and contain 26 bytes of User Data. The second MSP packet will have L-bit set to 0 and contain 16 bytes of User Data. At the A-SSE interface, verify that an MSP packet (Long Form) is received from the A-SSE on channel 1.

C.3.2.5 L-Bit Linking

(§C.2.2.6.3 – L-bit Processing)
(§C.2.2.8 – System Timers)

Objective: This test is designed to validate the L-bit linking function of the MSSS for long form MSP channels, and the use of the Tm timer for L-bit linking.

The Long Form MSP Packet test procedures are designed to test the A-SSE's ability to link Mode S Long Form MSP Packets when the packet size is greater than 28 bytes and the transponder has no downlink ELM capability.

Step 1 Use a selected MSP number, fill the Used Data Field with 32 bytes of the bit pattern 01010101. At the G-SSE interface, verify that two mode S long form MSP packets are received on the selected MSP channel from the A-SSE. The first frame will have L bit set to one and contain 26 bytes of user data. The second frame will have L bit set to zero and contain 6 bytes of user data.

Step 2 Send two Mode S Comm-A frames containing a linked Mode S Long Form MSP Packet to the A-SSE on a MSP channel number. Fill the UD Field with 26 bytes and 6 bytes respectively with the bit pattern 10101010. At the A-SSE interface, verify that a Mode S long form MSP packet is received from the AAE. Verify the UD Field for content and order.

L-bit Delivery Timer (Tm)

Step 1 From the GAE, create 2 long form MSP packets for delivery to the AAE. The first packet will have 26 bytes of user control data and L-bit set to ONE (1). The seconds packet will have 16 bytes of user control data and L-bit set to ZERO (0) for a complete sequence.

Step 2 After sending the first packet, send the second packet within the Tm time period. At the AAE interface, verify the receipt of this constructed packet containing 42 bytes of user control data in correct order and content.

Step 3 Repeat the process to generate the long form MSP packets again to the A-SSE, except this time, send the second packet after Tm time period. This allows the A-SSE to discard the complete sequence since the expiration of the Tm timer for L-bit sequencing.

Verify that there's no related output for this transaction at the AAE interface.

C.3.2.6 Link Frame Cancellation Timer (Tc)

(§C.2.2.7.2.5 – Frame Cancellation)
(§C.2.2.8 – System Timers)

Objective: This test is designed to validate the Tc frame cancellation timer of the frame processing function.

Step 1 From the GAE, generate two Short Form MSP packets with a 27 byte UD Field to fit into a four segment linked Comm-A message. The content of the UD Field will be a 1 in the first byte, 2 in the second byte, etc. Set II = 1 for all segments.

Step 2 Send only the first three Comm-A segments of the first frame to the A-SSE. Impose a delay of Tc minus two seconds, then send the final segment.

Step 3 Verify that the A-SSE receives an MSP message with a 27 byte UD Field in correct order and content.

Step 4 Repeat the process just described and transmit the first three Comm-A segments of the second frame. However, this time impose a delay of Tc plus two seconds between the transmission of the third and the final Comm-A segments. Verify that there is no output to the AAE.

C.3.2.7 Interrogator Link Timer (Tz)

C.4 Dataflash Application

C.4.1 Introduction

Eurocontrol has defined a Table of parameters available from aircraft systems that will be downlinked via Mode S to ATC ground systems. This information is intended to provide the ATC systems with more information to improve knowledge, amongst other things, on the aircraft's current status and its short term intent. The parameters are called Downlink Aircraft Parameters (DAPs). They can be acquired via the Mode S system by the use of either one of two Mode S protocols as follows:

Ground initiated Comm B (GICB) which requires regular interrogation of the aircraft to extract the parameter.

Dataflash is a contract-based service specified by ICAO in the Manual on Mode S Specific Services (ICAO Doc 9871, Appendix A). It relies on the aircraft system, announcing in its Mode S replies to surveillance interrogations, that a parameter in a contracted transponder register has changed according to rules agreed in the contract. It therefore does not require regular interrogations to check the status of the parameter.

C.4.2 The Choice of Protocol

Data that needs to be updated every few scans of the ground radar will normally be extracted by the ground system using the GICB protocol. To use this protocol to acquire data which does not necessarily change very often, results in a lot of interrogations and replies which provide the same information as the previous transaction, therefore causing unnecessary interference on the radio frequency channel.

Dataflash is a much more radio frequency channel efficient protocol that can be used to extract information that may not change very often, and Eurocontrol states using Mode S will therefore need to use this protocol.

C.4.3 EUROCAE Documentation

The Mode S transponder functions and protocols are fully covered by Eurocae ED-73C MOPS, and the Mode S Aircraft Data Link Processor (ADLP) functions and protocols by the ED-82A MOPS. The latter, however does not include MOPS for the Dataflash function because Dataflash is a Mode S Specific Services Application, and as such is not covered by the Mode S Subnetwork standards or MOPS.

A characteristic for a Mark 4 transponder has now been published in ED-86, requiring the Dataflash function to be part of the Mark 4 transponder. To locate Dataflash elsewhere would require a lot of data already residing in the transponder to be shipped out to the Dataflash function for monitoring and back in again when action is required. This would result in an unnecessary aircraft wiring and data-bus load. In order to permit full certification of such a transponder, Dataflash MOPS are required.

If the Dataflash application is implemented in an ADLP and a failure of the ADLP occurs, the only possible recovery mechanism is a power up restart to ensure that the ADLP is in the initialization state. Failure of the ADLP shall not impair the surveillance function of the transponder.

In the case of a single ADLP connected to two transponders, it shall be possible to switch over to the standby transponder without affecting the ADLP states.

C.4.4 Dataflash Requirements

All the requirements of Uplink MSP channel 6 when the Service Request header is set to 1 and those of Downlink MSP channel 3 shall be met as specified in ICAO Annex 10 Volume III Part 1 Digital Data Communications Systems.

The detailed requirements are stated in §C.4.6.

C.4.5 Document Precedence

If there is any conflict between this Appendix and ICAO Annex 10, the latter takes precedence.

C.4.6 Uplink MSP Channel 6 (Ground-to-Air Request)

C.4.6.1 Purpose

To provide a means of requesting access to services supported by the aircraft. When implemented, bit 6 of the register accessed by BDS Code 1,D shall be set to 1.

C.4.6.2 Format

The request shall be transferred in an uplink MSP packet with the channel number set to 6 and, in the case of a long form MSP packet, with SP set to ZERO (0). The first byte of the user data field contains a service request (SR) header. The contents and format of the service request are specified by the application.

C.4.6.3 SR Header Assignments

The decimal value of SR shall be interpreted as follows:

0	Unassigned
1	Dataflash
2	Local System Management
3 to 255	Unassigned

C.4.6.4 Dataflash Request Format

The purpose of Dataflash service is described in §C.4.7.1. The format of the user data field is shown in Table C-1. The user data field of the requesting MSP packet shall contain the decimal value of "ONE" in the first byte (SR header), followed by one or more requests for Dataflash services. Each request shall contain a two byte Dataflash request header (DH), followed by a one byte field to define the minimum time interval permitted between reports (MT field), a four bit field to determine the event criterion (EC field), a four bit field to determine stable time (ST field), and if indicated in EC, a Change Quanta field (CQ) and a Change Threshold (CT) field. The 4 bit ST field shall indicate the decimal value in seconds, how long the changed data has been stable before a message shall be initiated. ALL ZEROs in the Dataflash header (DH) shall indicate that there are no more Dataflash requests in the packet. When an MSP packet is completely filled with Dataflash requests, or when there is not sufficient room in the packet for another Dataflash request header, it shall be assumed that the Dataflash request sequence is complete.

A single Dataflash contract relates to a single contract number for a single register for a particular II code. This meets the requirement that multiple Dataflash services, with different DH values for each II code, can be established simultaneously with the same aircraft. These may be modified or discontinued independently of each other. All aircraft equipment and installations shall support 16 Dataflash contracts. All aircraft Dataflash equipment and installations originally certified after 1 January 2001 shall support 64 Dataflash contracts.

Note: When a request has been accepted by the aircraft system a data flash response will be triggered immediately regardless of thresholds or event criteria. If no response is received in 30 seconds then a check should be made that the aircraft is still available on roll call, and if so a new request should be generated. In order to avoid repeated Dataflash requests that produce no response, the number of such requests (N) should be limited (N=3).

When a new contract request is received for a contract already in existence, the old contract shall be discontinued and replaced immediately by the latest one.

C.4.6.5 Dataflash Header (DH) 16 Bits

The 16 bit DH field is divided into three subfields separated by 3 currently unassigned bits 14 through 16 (see Table C-1).

C.4.6.5.1 Contract Number Subfield (CNS) 4-Bits. (Bits 9 to 12 of the Uplink MSP 6 User Data Field)

This subfield shall be interpreted as a contract number permitting 16 different contracts to be associated with the register specified by the BDS1 and BDS2 codes of this contract request.

Contract numbers available are 0 to 15.

C.4.6.5.2 Request Data Subfield (RDS) 1-Bit. (Bit 13 of the Uplink MSP 6 User Data Field)

This subfield shall indicate whether or not the contents of the register being monitored by the requested contract must be sent in the MSP Packets on Downlink channel 3 that are sent each time the criterion for the contract is met.

The subfield shall be interpreted as follows:

RDS = 0 Send only bits 1 to 40 of the user data field on Downlink MSP 3 when the contract criterion is met.

RDS = 1 Send bits 1 to 96 of the user data field on Downlink MSP 3 when the contract criterion is met.

Note: RDS only indicates the length of the user data field in Downlink MSP3 when responding with a value zero in the CI field (see §C.7.4.3.1).

C.4.6.5.3 BDS1 and BDS2 Codes of the Register for Which the Contract is Required. 8 Bits. (Bits 17 to 24 of the Uplink MSP 6 User Data Field)

BDS1 and BDS2 codes are specified in Annex 10 Volume IV.

C.4.6.6 Minimum Time (MT) 8 Bits

The decimal value of the 8 bit MT field represents the minimum time in seconds that shall elapse after a report has been event triggered and sent to the transponder, before a new report can be initiated. The report sent to the transponder shall always be the most current data available.

C.4.6.7 Event Initiation

Event initiation shall be controlled by the two following fields.

C.4.6.7.1 Event Criterion Field (EC) 4 Bits

These are the four bits following the MT field. If multiple events occur within a single register being monitored by a Dataflash contract, (e.g., if more than one parameter shows a significant change) only one message shall be triggered.

The decimal value of the EC field shall be interpreted as follows:

0 = No report required, discontinue service for the contract specified in the DH field.

1 = Report any change.

2 = 56 bit change field (CQ) follows ST. Only report changes to bits indicated by a “ONE” in CQ.

3 = 56 bit field CQ follows ST. For each parameter report all status changes and all changes of the parameter greater than the quantum value indicated in the

same units and resolution of the field in CQ corresponding to that parameter. A zero in the field in CQ corresponding to the parameter indicates that no reports are required.

4 = 112 bits CQ plus CT follow ST. The first 56 bits are as for the EC value 3 above. The second 56 bits are the CT field indicating a threshold value in the field corresponding to the parameter. Report all changes above the threshold where the value in CQ gives the change quantum.

5 = 112 bits of CQ and CT follow ST. Same as for the EC value 4 above except: report all changes below the threshold.

6 = 112 bits of CQ and CT follow ST. Same as for ECS values 4 and 5 above except report only when the threshold is crossed (in either direction).

7 to 14 = Not currently assigned.

15 = Cancel all contracts for the II code in this request.

C.4.6.7.2 Stable Time Field (ST) 4 Bits

These are the four bits following the EC field. The decimal value of ST shall indicate in seconds, how long the changed data have been stable to within the change quanta specified in CQ field, before a message shall be initiated. A value of ZERO (0) in this subfield shall indicate that there is no minimum stable time and any change immediately initiates a message. The significance of the ST will differ slightly depending upon which EC mode is being used. In particular, for EC modes 4 & 5, regarding stability whilst above/below a threshold, if a parameter value remains above/below the defined threshold for greater than the ST time then a Dataflash shall be generated even if the value does not remain stable to within one quantum. Subsequent quantum changes which are stable for greater than the ST time shall generate further Dataflash messages until the value falls below / rises above the threshold.

C.4.6.7.3 Change Fields – Change Quanta (CQ) and Change Threshold (CT)

These fields shall be present when indicated in EC. For a GICB service (i.e., for DH from 1 to 255 inclusive), CQ shall be contained in bits 41 to 96 of the MSP 6 User Data Field. CT when required shall be contained in bits 97 to 152 of the MSP 6 User Data Field. The quantum value in the CQ field shall be in the same units and resolution as those specified for the register being monitored and it specifies the amount by which the parameter shall change, from its value at the initialization of the contract, and thereafter from the value last reported by a Dataflash response on downlink channel MSP 3.

Table C-1: Request for Dataflash Register monitoring Service Mode S SLM Frame Containing (Uplink MSP Channel 6)

MSP (6) USER DATA FIELD
Bits 1 to 40

Bit	Field		
	DP = 0 (1 BIT)		UPLINK MSP HEADER (1 BYTE)
	MP = 0 (1 BIT)		
	M/CH = 6 (6 BITS)		
1	SERVICE REQUEST (SR)		
2			
3			
4			
5			
6			
7			
8			
9	CONTRACT NUMBER SUBFIELD (CNS)	DATAFLASH HEADER (DH)	
10			
11			
12			
13	REQUEST DATA (RDS)		
14	NOT ASSIGNED		
15			
16			
17	BDS1 CODE		
18			
19			
20			
21	BDS2 CODE		
22			
23			
24			
25	MINIMUM TIME (MT) INTERVAL		
26			
27			
28			
29			
30			
31			
32	LSB = 1 second		
33	EVENT CRITERION (EC)		
34			
35			
36			
37	STABLE TIME (ST)		
38			
39			
40	LSB = 1 second		

MSP (6) USER DATA FIELD
Bits 41 to 96 (if required)

Bit	Field
41	CHANGE QUANTA FIELD (CQ)
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
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MSP (6) USER DATA FIELD
Bits 97 to 152 (if required)

Bit	Field
97	CHANGE THRESHOLD FIELD (CT)
98	
99	
100	
101	
102	
103	
104	
105	
106	
107	
108	
109	
110	
111	
112	
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146	
147	
148	
149	
150	
151	
152	

The last byte of the final MA field shall always be unassigned

Note: *See Annex 10 Volume III §5.2.7.3 for specification of MSP Packets.*

C.4.7 Downlink MSL Channel 3. Dataflash Service

C.4.7.1 Purpose

Dataflash is a service which announces the availability of information from air-to-ground on an event triggered basis. This is an efficient means of downlinking information which changes occasionally and unpredictably. When implemented, bit 31 of the register accessed by BDS Code 1,D shall be set to 1.

C.4.7.2 Service Initiation and Termination

The Dataflash service shall be initiated or discontinued by a service request. It is received on uplink MSP channel 6 with a decimal value of ONE in the service request (SR) header which is contained in the first byte of the user data field. This indicates that the rest of the user data field contains Dataflash request. On the receipt of such a request a Dataflash message from the register concerned with the request, shall immediately be made available and announced to the ground regardless of the setting of the RDS field in the contract request and of any event criteria.

The response shall be as follows:

1. When the requested register is being serviced, the contract shall be established and an MSP Packet as in Table C-2 shall be announced to the ground on MSP channel 3. The CI field shall be set to a value of 1. The message shall be used by the ground system to confirm that the service has been initiated.

2. If the requested register is not being serviced the contract shall not be established. This shall be indicated by announcing the MSP Packet on Downlink MSP channel 3 to the ground as shown in Table C-2, and with a value of 2 in the CI field.

3. If the maximum number of contracts that can be supported are already established then the new contract shall be refused. This shall be indicated by announcing to the ground an MSP Packet on Downlink channel 3, as shown in Table C-2, and with a value of 3 in the CI field.

4. In the case of a request from the ground to terminate the service for a particular register the termination of the service shall be confirmed by announcing to the ground, an MSP Packet on Downlink channel 3, as shown in Table C-2, and with a value of 4 in the CI field.

5. In the case of a request from the ground to terminate the service for all contracts to a particular II code. The termination of the service shall be confirmed by announcing to the ground, an MSP Packet on Downlink channel 3, as shown in Table C-2, and with a value of 5 in the CI field.

6. When the register service fails for an established contract, the contract shall be terminated by the airborne application. This shall be indicated by announcing an MSP Packet on Downlink channel 3, to the ground, as shown in Table C-2, and with a value of 7 in the CI field. Register service shall be deemed to have failed

when any of the parameters specified to be monitored in the negotiation of the contract is not being updated at the specified minimum rate.

7. When a contract is refused due an invalid value of the EC field in the contract request this shall be indicated by announcing an MSP Packet on Downlink channel 3 to the ground as shown in Table C-2, and with a value of 15 in the CI field.

8. If any message is not extracted from the transponder by a ground interrogator within 30 seconds the aircraft subnetwork cancels the message and generates a delivery failure notice (i.e., the TZ timer expires) which is delivered to the aircraft MSP service provider. When a delivery failure notice is received the service shall be automatically terminated by the Dataflash function with no indication to the ground system.

Note: This is to prevent the transponder message queues being blocked when the ground interrogator stops supplying the message extraction service, either due to a fault or loss of cover. It is the responsibility of the ground application to monitor the Dataflash service taking this into account.

9. When the transponder has not been selectively interrogated by a Mode S interrogator with a particular II code for 60 seconds (this is determined by monitoring the IIS subfield in all accepted Mode S interrogations), all Dataflash contracts related to that II code shall be cancelled with no indication to the ground system.

C.4.7.3 Service Provision

On the reception of a Dataflash request the requested parameters shall be monitored and transferred to the ground using the Mode S air initiated protocols directed to the II code that was contained in the requesting interrogation. In order to prevent the flooding of the transponder with Dataflash messages, an upper limit of ten messages in a six seconds period shall be imposed. When the limit of ten messages within a six seconds period is reached, further messages shall be queued until they can be sent. Messages queued in this way shall respond with a CI field value of 6.

If after initiating a Dataflash message to the ground, the change criterion is met again prior to the message being entered into the transponder for announcement, the message is considered stale and shall be replaced by the most up to date information.

C.4.7.4 Downlink Message Structure

The information shall be transferred in a downlink MSP packet with the channel number M/CH = 3. The format is shown in Table C-2.

The first two bytes of the User Data (UD) field shall contain a Dataflash header (DH), which are identical to the DH field that was contained in the request for the service.

C.4.7.4.1 Bits 17 to 31 of UD form the II code Contract Report Field in which each bit shall indicate that at least one contract is active with the II code which the bit represents when it is set to a ONE, otherwise there are no active contracts with that II code.

C.4.7.4.2 Bits 32 to 36 of UD are not assigned.

C.4.7.4.3 **Bits 37 to 40 of UD form the Contract Information (CI) field which shall be interpreted as follows:**

CI Field Value	Meaning
0	Response to existing contract
1	New contract established
2	New contract not accepted due to no register data service
3	New contract not accepted due to maximum number of contracts already being serviced.
4	Contract terminated for the DH in this response due to a request from the ground.
5	All contracts terminated for the II code that delivered the MSP Packet having an EC value of 15 that requested this response. Response has been queued due to the limit of ten Dataflash messages in a six seconds period. Contract terminated due to failure of the register data service.
8 to 14	Unassigned
15	New contract not accepted due to invalid number in EC field of requesting uplink MSP Packet.

C.4.7.4.3.1 When the CI field is equal to ZERO the response shall be as requested by the RDS field in the Dataflash header of the contract (see §C.4.6.5.2). When the CI field is not equal to ZERO the response shall only contain bits 1 to 40 of the user data field on downlink MSP 3 (see Table C-2).

C.4.7.5 Data Extraction by Mode-S Ground Stations

The Dataflash transaction shall be announced as a downlink frame in replies to interrogations UF 4, 5, 20, or 21. The transaction announced shall be either a single segment Comm B frame, or a two segment Comm B frame, as requested by the contract negotiation. The Air Directed Comm B first segment shall contain the MSP header, Dataflash header, and control information for that particular contract. In the case of a contract for a single segment response, if the data is required, it is acquired by the ground station extracting the register in question directly.

Table C-2: Dataflash for Register Monitoring Service
(Mode-S Frame for Downlink MSP Channel 3)

MSP (3) USER DATA FIELD Bits 1 to 40 | **MSP (3) USER DATA FIELD Bits 41 to 96**

Bits 1 to 40	Subfield	Group	Bits 41 to 96	
	LINKED COMM B SUBFIELD (LBS) (2 BITS)		41 42	
	DP = 1 (1 BIT)	MSP HEADER	43	
	MP = 0 (1 BIT)		44	
	M/CH = 3 (6 BITS)		45 46 47 48 49 50	
	FILL 1 = 0 (6 BITS)		51 52 53 54 55 56	
1 2 3 4	CONTRACT NUMBER SUBFIELD (CNS)	DATAFLASH HEADER (DH)	57 58 59 60	REGISTER MESSAGE CONTENT
5	REQUEST DATA SUBFIELD (RDS)		61	
6 7 8	NOT ASSIGNED		62 63 64	
9 10 11 12	BDS1 CODE		65 66 67 68	
13 14 15 16	BDS2 CODE		69 70 71 72	
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	II=1 II=2 II=3 II=4 II=5 II=6 II=7 II=8 II=9 II=10 II=11 II=12 II=13 II=14 II=15	II CODE CONTRACT REPORT (CR)	73 74 75 76 77 78 79 80 81 82 83 84 85 86 87	
32 33 34 35 36	NOT ASSIGNED		88 89 90 91 92	
37 38 39 40	CONTRACT INFORMATION (CI)		93 94 95 96	

Note: See Annex 10 Volume III §5.2.7.3 for specification of MSP Packets

C.4.7.6 Data flash Requirement/Test Cross Reference Table

Table C-3 lists all requirements and gives the test section Procedures which test each requirement.

Table C-3: Dataflash Requirements/Test Cross-Reference

Requirement Paragraph No	Headline	Test Chapter Paragraph No	Related test
§C.6	Uplink MSP channel 6		headline
§C.6.1	Purpose	§C.8.2.1	Procedure 1 Step 1
§C.6.2	Format		uplink requirement
§C.6.3	SR header assignments	§C.8.2.2	Procedure 2 Step 2
§C.6.4	Dataflash request format	§C.8.2.2	Procedure 2 Step 2
§C.6.5	Dataflash header (DH) 16 bits		introduction
§C.6.5.1	Contract number Subfield (CNS)	§C.8.2.4	Procedure 4 Step 1
§C.6.5.2	Request Data Subfield (RDS)	§C.8.2.2	Procedure 2 Step 2
§C.6.5.3	BDS 1 and BDS2 codes of the register for which the contract is required.	§C.8.2.2	Procedure 2 Step 2
§C.6.6	Minimum time (MT)	§C.8.2.5	Procedure 5 Steps 1, 2
§C.6.7	Event Initiation		introduction
§C.6.7.1	Event Criterion field (EC) -a. EC = 0	§C.8.2.3	Procedure 3 Step 1
	-b. EC = 1	§C.8.2.2	Procedure 2 Step 1
	-c. EC = 2	§C.8.2.6	Procedure 6 Step 1
	-d. EC = 3	§C.8.2.6	Procedure 6 Step 2 Procedure 6 Step 3
	-e. EC = 4	§C.8.2.6	Procedure 6 Step 4
	-f. EC = 5	§C.8.2.6	Procedure 6 Step 5
	-g. EC = 6	§C.8.2.6	Procedure 6 Step 6
	-h. EC = 7-14	§C.8.2.6	Procedure 6 Step 9
	-i. EC = 15	§C.8.2.6	Procedure 6 Step 7
§C.6.7.2	Stable time (ST) field	§C.8.2.7	Procedure 7 Step 1
§C.6.8	Change fields - -a. Change Quanta (CQ)	§C.8.2.6	Procedure 6 Step 2 (LSB) Procedure 6 Step 3 (MSB)
	-b. Change Threshold (CT)	§C.8.2.6	Procedure 6 Step 4
Table C-1	MSP packet User Data (MSP 6)		implicitly tested
§C.7	Downlink MSP Channel 3 Dataflash Service		headline
§C.7.1	Purpose		introduction
§C.7.2	Service initiation and termination		implicitly tested
§C.7.2.1	Initiation action (contract established)	§C.8.2.2	Procedure 2 Step 2
§C.7.2.2	Initiation action (register not serviced)	§C.8.2.2	Procedure 2 Step 1
§C.7.2.3	Initiation action (maximum number of contracts)	§C.8.2.2	Procedure 2 Step 2
§C.7.2.4	Initiation action (contract terminated)	§C.8.2.3	Procedure 3 Step 1
§C.7.2.5	Initiation action (all contracts terminated)	§C.8.2.6	Procedure 6 Step 7
§C.7.2.6	Initiation action (contract establishment failed)	§C.8.2.3	Procedure 3 Step 2
§C.7.2.7	Initiation action (EC field error)	§C.8.2.6	Procedure 6 Step 8
§C.7.2.8	Delivery failure notice	§C.8.2.3	Procedure 3 Step 3
§C.7.2.9	Non-interrogation timeout	§C.8.2.3	Procedure 3 Step 4
§C.7.3	Service provision	§C.8.2.8	Procedure 8 Step 3
§C.7.4	Downlink message structure		implicitly tested
§C.7.4.1	Contract report field.	§C.8.2.2	Procedure 2 Steps 1,2,3

Requirement Paragraph No	Headline	Test Chapter Paragraph No	Related test
§C.7.4.2	Unassigned bits		implicitly tested
§C.7.4.3	Contract information field -a. CI = 0	§C.8.2.5	Procedure 5 Step 2
	-b. CI = 1	§C.8.2.2	Procedure 2 Step 2
	-c. CI = 2	§C.8.2.2	Procedure 2 Step 1
	-d. CI = 3	§C.8.2.2	Procedure 2 Step 2
	-e. CI = 4	§C.8.2.2	Procedure 3 Step 1
	-f. CI = 5	§C.8.2.6	Procedure 6 Step 7
	-g. CI = 6	§C.8.2.8	Procedure 8 Step 3
	-h. CI = 7	§C.8.2.3	Procedure 3 Step 2
	-i. CI = 8-14		implicitly tested
	-j. CI = 15	§C.8.2.6	Procedure 6 Step 9
§C.7.4.3.1	Response type	§C.8.2.2	Procedure 2 Step 2
§C.4.7.5	Data Extraction by Mode S Ground stations		Implicitly tested
Table C-2	Dataflash for Register Monitoring service		implicitly tested

C.4.8 Test Procedures for Dataflash Application

C.4.8.1 Test Equipment

a. A Mode S transponder and a means to input and record test data into the Mode S transponder registers from simulated aircraft data buses at the required rates. (This may be done via an ADLP if the transponder does not have the Dataflash application inside it).

b. A means to interrogate the Mode S transponder at a regular rate between 6 and 10 seconds with surveillance interrogations and decode the replies.

c. A means to send data to the transponder, extract air initiated messages announced by the transponder, and extract the data from the transponder registers of the transponder, by means of interrogations with the appropriate control codes set.

d. A means to set up, record, and monitor Dataflash contracts by interrogating the Mode S transponder. Also a means of extracting and recording the data from the transponder when announced in the reply to a background surveillance interrogation.

The test equipment and its configuration will be dependent on where the Dataflash function resides. There are several possibilities, two examples of which are, either in an ADLP separate from a transponder, or in a combined ADLP transponder unit such as a Mark 4 transponder. The manufacturer shall declare the monitoring points to be used and offer a test equipment configuration to meet the requirements of the tests. Two possible test equipment configurations are shown in Figure C-1.

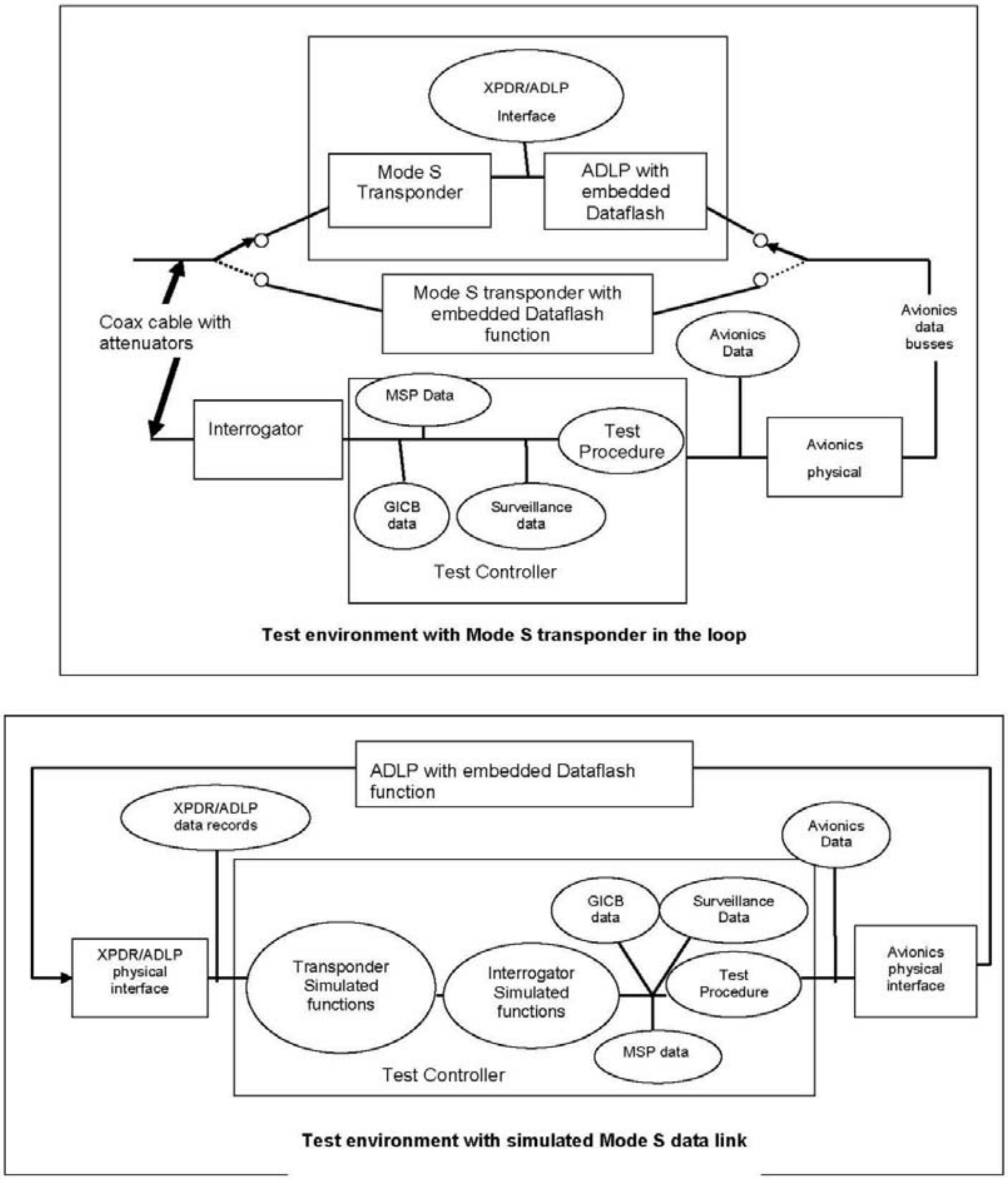

Figure C-1: Two Possible Test Equipment Options for Testing the Dataflash Application

C.4.8.2 Test Procedures

C.4.8.2.1 Procedure #1: Initialization and Checking for Dataflash Support (Reference: §C.6.1)

This test procedure shall be carried out at the start of each test sequence to verify that the airborne Mode S system is functioning correctly and can support uplink MSP channel 6, downlink MSP channel 3, and the appropriate transponder registers.

Step 1 – MSPs installed and require service

a. Switch on the Mode S system under test and the test equipment and set the test interrogation II code to a non-zero value.

b. Start a regular pattern (one interrogation every 6 to 10 seconds) of Mode S Surveillance interrogations as shown in Table C-4.

Table C-4: Surveillance Interrogation

UF = 4 or 5	PC = 0	RR = 0	DI = 7	SD						AP
				IIS	RRS = 0		LOS = 0		TMS = 0	

c. Check that the specified replies are received and decoded correctly.

d. Extract the data from a transponder register using an interrogation as in Table C-4, but setting the RR field to 17 and the RRS subfield to ZERO (0). (This is a request for the Data Link Capability Report.)

e. Verify in the MB field of the reply that bit 25 is set to ONE (1). (This indicates that MSP services are supported.)

f. Extract the data from a transponder register using an interrogation as in Table C-4, but setting the RR field to 17 and the RRS subfield to 13. (This is a request for one of the Mode S Specific Services MSP capability report registers.)

g. Check in the MB field of the reply that bit 6 is set to ONE (1) indicating that MSP Uplink Channel 6 is installed and requires service, and that bit 31 is set to ONE (1) indicating that Downlink Channel 3 is installed and requires service.

Step 2 – Transponder Register data sources installed

a. Extract the data from a transponder register using an interrogation as in Table C-4, but setting the RR field to 17 and the RRS subfield to 8. (This is a request for one of the Mode S Specific Services MSP capability report registers.)

b. Check in the MB field of the reply and record the bits that are set to a ONE indicating that a transponder register service is indicated as installed.

c. Repeat Step 2 four times incrementing the RRS subfield by 1 each time to give RRS values 9, 10, 11, and 12.

Step 3 – Transponder Register data loading

a. Load known data into all transponder registers, indicated as installed from Step 2 above, in the transponder that contain other than static data (i.e., GICB capability report register etc.) at the minimum rate specified in ICAO Document 9688.

b. Extract the data from each register and verify that the data is correct.

c. Cease loading data into the transponder registers.

d. After a delay of at least twice the required update rate extract the data from each register and verify that the data is ALL ZEROs.

C.4.8.2.2 Procedure #2: Requesting the setup of Dataflash Contracts

(Reference: §C.4.6.3, §C.4.6.4, §C.4.6.5.2, §C.4.6.5.3, §C.4.6.7.1, §C.7.2.1, §C.7.2.2, §C.7.2.3, §C.7.4.1, §C.7.4.3 & §C.7.4.3.1)

This test procedure is to check that the Dataflash application will not set up a contract for a transponder register that is not being serviced and that a contract can be set up when the transponder register is being serviced. It also checks that the maximum number of contracts for which the system is declared to be capable of handling can be set up. It also tests the function of CR field, the RDS field, and CI field values 1, 2, and 3.

Step 1 – Dataflash contract request for transponder registers not being loaded with data

a. Ensure that no data is being loaded into the installed transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-5, on uplink MSP channel 6 with the BDS1 and BDS2 codes of the transponder register with which the contract is intended set into the DH field.

Table C-5: MSP Packet on MSP Channel 6

SR =1	DH					MT = 0	EC = 1	ST = 0
	CNS = 0	RDS = 1	Spare	BDS1	BDS2			

Note: *Mode S Frames are specified and tested in EUROCAE document ED-82.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder 0.1 seconds after the uplink frame in “b” above was received by the transponder.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-6 and it contains a DH equal to the value in the request interrogation and a value of 2 in the CI field. (This indicates that the contract was not accepted). Also verify that the CR field contains ALL ZEROs. (This indicates that there are no Dataflash contracts in existence.)

Note: *Since RDS = 1 in the contract request this test also verifies that the message register content is not sent when the register is not being loaded with data.*

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 requesting a contract for all transponder registers indicated as installed in the results of Procedure 1 Step 2.

Step 2 – Contract establishment for transponder registers being loaded with data

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder register.

b. Send a Mode S uplink frame to the transponder as specified in Table C-5 but with RDS=0, containing an MSP packet on uplink MSP channel 6.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-7 and that it contains a DH equal to the value in the request interrogation. Verify that the CI field is set to ONE (1) when the contract is accepted, and that CI = 3 and the MSP packet is as shown in Table C-7, when the maximum number of contracts is exceeded. (This indicates that the contents of the transponder register are made available when the contract is established even though RDS=0). Also verify that in the CR field, the bit relating to the II code in the requesting interrogation is set to a ONE (1) for all II codes for which contracts have been accepted. (This indicates the contracts that have been accepted and are active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the data in the transponder register so that the criterion for a Dataflash message to be triggered is met.

g. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the data changed.

h. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-6. Verify that it contains a DH equal to the value in the request interrogation in Step 2 “b”. Verify that the CI field is set to ZERO (0). (This indicates that after the contract has been established the transponder register data is not made available because RDS=0 in the contract request.)

Table C-6: MSP Packet on Downlink MSP Channel 3

DH (16 bits)	CR (15 bits)	Not Assigned (5 bits)	CI (4 bits)

i. Repeat Step 2 “b” to “c” but setting RDS=1 in Step 2 “b”.

j. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-7, and that it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to ONE (1) when the contract is accepted and CI = 3 when the maximum number of contracts is exceeded. Also verify that in the CR field, the bit relating to the II code in the requesting interrogation is set to a ONE (1) for all II codes for which contracts have been accepted. (This indicates the contracts that have been accepted and are active.) Verify that the register message content is that which was loaded into the register specified in the contract request.

Table C-7: MSP Packet on Downlink MSP Channel 3

DH (16 bits)	CR (15 bits)	Not Assigned (5 bits)	CI (4 bits)	Register message content (56 bits)

k. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

l. Change the data in the transponder register so that the criterion for a Dataflash message to be triggered is met.

m. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 second after the data changed.

n. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-7. Verify that it contains a DH equal to the value in the request interrogation in Step 2 “b”. Verify that the CI field is set to ZERO (0). (This indicates that after the contract has been established the transponder register data is made available because RDS=1 in the contract request.)

o. Repeat Procedure 2 Step 2 “a” to “e”, using a different non-zero II code each time requesting contracts up to a value equal to the maximum number of contracts that the system is declared to be capable of handling plus one. Use other transponder registers indicated as “installed” in the results of Procedure 1 Step 2 if the maximum number of contracts is more than 16.

p. Record the maximum number of contracts accepted, and verify that the number is at least 16, and that it is the maximum number declared by the manufacturer for the unit under test.

q. Use the techniques in §C.4.8.2.3 Procedure 3 to terminate all the contracts.

Step 3 – Multiple contract requests contained in a single MSP Packet on MSP channel 6

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder register.

b. Depending on the transponder Level, send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-8 or Table C-9 with RDS=1 in the Dataflash Header(DH), on uplink MSP channel 6 with different BDS codes of transponder registers being loaded in a above for each contract request.

Table C-8: MSP Packet Containing Multiple Contract Requests for a Level 2 Transponder

	Contract 1				Contract 2						END
SR=1	DH	MT	EC=1	ST	DH	MT	EC=4	ST	CQ Quanta	CT Threshold	DH=0

This will result in an Uplink 4 Segment Linked Comm A frame.

Table C-9: MSP Packet Containing Multiple Contract Requests for Level 3 and above Transponders

	Contract 1				Contract 2					Contract 3						END	Fill data
SR=1	DH	MT	EC=1	ST	DH	MT	EC=2	ST	CQ Quanta	DH	MT	EC=4	ST	CQ Quanta	CT Threshold	DH=0	All ZEROs

This will result in an Uplink ELM frame

c. Verify that downlink transactions directed to the II code that was used in the requesting transaction in "b" above, are announced by the transponder in replies to surveillance interrogations sent to the transponder, the first one, no later than 0.1 seconds after the uplink frame in "b" above was sent and one for each subsequent contract request as soon as the previous transaction has been closed out.

d. Extract each downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-7, and that it contains DH equal to the value in the contract request interrogation, and verify that the CI field is set to ONE (1) and the relevant bit of the CR field is set to ONE (1) indicating the same II code as was set in the interrogation requesting transaction in "b" above. (This indicates that the contract was accepted and is active.)

e. Verify that all the requested contracts have been accepted.

f. Closeout each downlink transaction by means of a surveillance interrogation to the transponder.

g. Use the techniques in §C.4.8.2.3 Procedure 3 to terminate all the contracts.

Step 4 – Tests of wrong values in the Service Request (SR) header in MSP packet on uplink MSP channel 6

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as in Table C-5, on uplink MSP channel 6, but with the SR field set to ZERO (0).

c. Verify that no downlink transaction is announced by the transponder in the reply to a surveillance interrogation as in Table C-4, sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent. (No downlink response indicates that the contract was not accepted.)

d. Repeat Step 1 requesting the same contract using all other SR values. i.e., 2 to 255 inclusive and verify that no Dataflash downlink transactions are announced by the transponder.

C.4.8.2.3 Procedure #3: Termination of Dataflash Contracts

(Reference: §C.4.6.7.1, §C.7.2.4, §C.7.2.6, §C.7.2.8, §C.7.2.9, & §C.7.4.3)

This Procedure tests the different methods of terminating Dataflash contracts and can be performed in conjunction with Procedure 2 of §0 in order to minimize the total number of tests required.

Step 1 – Dataflash contract termination by the interrogator using the EC Field

a. Establish the maximum number of contracts as in Procedure 2 §0.

b. For an established contract send a Mode S uplink Frame containing an MSP packet as in Table C-5, on uplink MSP channel 6, but with the EC Field set to ZERO (0). (This should cause the contract to be cancelled.)

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after each uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet as shown in Table C-7, on Downlink MSP channel 3 and it contains a DH field corresponding to the contract to be cancelled and that the CI field is set to a value of 4. (This indicates that the contract has been cancelled.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 for all the established contracts.

Step 2 – Dataflash contract termination by transponder register losing its source data

a. Establish the maximum number of contracts as in Procedure 2 Step 2 sections “a” to “e” in §0.

b. For an established contract discontinue the loading of the relevant transponder register. (This should cause the contract to be cancelled.)

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation shown in Table C-4, sent to the transponder no later than 0.1 seconds after each uplink frame in “b” above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH field corresponding to the contract for the transponder register which is no longer serviced and that the CI field is set to a value of 7. (This indicates that the contract has been cancelled.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 for all the established contracts.

Step 3 – Dataflash contract termination by the airborne application due to link failure

a. Establish a contract as in Procedure 2 Step 2 sections “a” to “e,” in §0.

b. Change and record the data pattern being loaded into the relevant transponder register.

c. Verify that a downlink transaction is announced by the transponder, directed to the II code that was used in the requesting transaction, in the reply to a surveillance interrogation shown in Table C-4, sent to the transponder no later than 0.1 seconds after the data change in “b” above.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH field equal to that in the request interrogation, and verify that the CI field is set to ZERO. (This indicates that the contract has detected the change in data and is functioning correctly.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change and record the data pattern being loaded into the relevant transponder register.

g. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation no later than 1 second after the data change in "f" above.

h. Wait 35 seconds.

i. Verify that a downlink transaction is no longer announced in replies to surveillance interrogations. (This indicates that the airborne system has declared a link failure and should have terminated the contract).

j. Change the data pattern being loaded into the relevant transponder register and record the new pattern.

Verify that NO downlink transaction is announced by the transponder in the reply to surveillance interrogations after the data change in "j" above. (This means that the contract has been cancelled by the airborne system.)

Step 4 – Dataflash contract termination due to loss of service from an interrogator with the same II code as the one that initiated the contract

a. Establish a contract as in Procedure 2 Step 2 sections "a" to "e," in §0.

b. Change and record the data pattern being loaded into the relevant transponder register.

c. Verify that a downlink transaction is announced by the transponder, directed to the II code that was used in the requesting transaction, in the reply to a surveillance interrogation shown in Table C-4, sent to the transponder no later than 0.1 seconds after the data change in "b" above.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH field equal to that in the request interrogation, and verify that the CI field is set to ZERO. (This indicates that the contract has detected the change in data and is functioning correctly.)

e. Change the II code of all interrogations to the transponder, record the new II code, and repeat "a" to "d" above. Verify in the CR field of the response in "d" above, that contracts are indicated for both the original and the new II codes.

f. Wait 60 seconds from the time of the last interrogation with the original II code and repeat "b" to "d" above. Verify in the response to "d" above that the CR field indicates no contracts for the original II code. (This confirms that the contracts to the original II code have been cancelled.)

g. Repeat the whole of Step 4 "a" to "f" to test all II codes as the original II code.

C.4.8.2.4 Procedure #4: Dataflash Header (DH) Field Tests

(Reference: §C.4.6.5.1)

This Procedure tests for the correct interpretation of the Contract Number Subfield (CNS) in the DH field. The BDS code subfield interpretation is tested in §0 Procedure #2 Step 2.

Step 1 – Establishing multiple contracts with a single transponder register

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-5, with the BDS1 and BDS2 codes set for a contract with a selected transponder register.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 "a" to "e" using the same BDS1 and BDS2 codes in the interrogations in "c" above, and setting each of the other values in the CNS subfield in turn in "b" above.

g. Repeat Step 1 "a" to "f" for at least three different transponder registers.

Note: *If in "f" or "g" above the maximum number of contracts that the transponder can handle is reached, the contracts must be terminated by the method used in Procedure 3 Step 1 in §C.4.8.2.3 above, and this test continued to test all CNS values.*

h. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

C.4.8.2.5 Procedure #5: Minimum Time (MT) Field Tests

(Reference: §C.4.6.6 & §C.7.4.3)

This Procedure tests for the correct interpretation of the Minimum Time (MT) field contained in the MSP packet of uplink MSP channel 6.

Step 1 – Data changing at longer intervals than the value in the MT field

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-5.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in “b” above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the transponder register data being loaded into the transponder register which was indicated in the contract initiated in “a” to “d” above.

g. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the transponder register data was changed in the transponder register.

h. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1).

i. Use an interrogation as in Table C-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 “f.” Verify that it contains the new changed data that was loaded into that transponder register. (This indicates that the changed data is immediately available as requested in the MT field.)

j. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

k. Repeat Step 1 “f” to “j” at least 10 times and verify that all the data changes are reported.

l. Repeat Step 1 "f" to "k" for values of 10, 50, 100, 150, and 255 seconds set into the MT field of the MSP packet in "b" above, and the transponder register data changes of "f" above, at rates of 11, 51, 101, 151, and 256 seconds respectively.

m. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 2 – Data changing at shorter intervals than the value in the MT field

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-5.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the contract by sending a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-5, but with the MT field set to ONE (1) second.

g. Change data being loaded into the transponder register at time intervals approximately equal to a quarter of the time indicated in the MT field of the requesting contract.

h. Verify that a downlink transaction is NOT announced by the transponder in the reply to a surveillance interrogation sent to the transponder at any time earlier than the value in MT field.

i. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than the value in the MT field plus 0.1 seconds after the previous data extraction.

j. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to ZERO (0). (This indicates a response to an existing contract.)

k. Use an interrogation as in Table C-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 2 “f” above. Verify that it contains the latest data that was loaded into that transponder register before expiry of the time value in the MT field. (This indicates that the MT field is being interpreted correctly.)

l. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

m. Repeat Step 1 “f” to “l” with MT values of 10, 50, 100, 150, 200, and 255 seconds being set into the MSP packet on MSP uplink channel 6 of “f” above.

n. Terminate the contract by the method used in §C.4.8.2.3 Procedure 3 Step 1.

C.4.8.2.6 Procedure #6: Event Criterion (EC) Field Tests

(Reference: §C.4.6.7.1, §C.4.6.7.3, §C.7.2.5, §C.7.2.7, & §C.7.4.3)

This Procedure tests the 4 bit Event Criterion Field (EC. Tests for the EC values of ZERO (0) and ONE (1) are covered in the previous Procedures. CI field values 0, 1, 3, and 5, and CR field bit tests are included in this Procedure.

Step 1 – Tests with EC Field = 2

a. Ensure that data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-10 with BDS1 and BDS2 codes to set up a contract with the register being loaded in “a” above, and the bits in the Change Quanta (CQ) field set to alternating Zeros and Ones, starting with a ZERO (0).

Table C-10: MSP Packet on MSP Channel 6 with EC=2

SR=1	DH					MT=0	EC=2	ST=0	CQ Quanta (56 bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2				

Note: *When EC=2 the Change Quanta (CQ) field is interpreted as 56 individual bits. When a bit is set to ZERO, the corresponding bit in the transponder register is not monitored and when it is set to a ONE a report is sent whenever the corresponding bit in the transponder register changes.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in “b” above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each bit in the transponder register in turn, change that bit and perform "g," "h," "i," "j," and "k" below.

g. When the corresponding bit in the CQ Quanta is set to a ONE verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "f" above was sent.

h. When the corresponding bit in the CQ Quanta is set to a ZERO (0) verify that NO downlink transaction is announced by the transponder in the reply to a surveillance interrogation.

i. Extract all announced downlink transactions, and verify that they are MSP Packets on Downlink MSP channel 3 as in Table C-7, and they contain a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO.

j. Use an interrogation as in Table C-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 "b" above. Verify that it contains the data that was loaded into that transponder register. (This indicates that the change monitoring is functioning correctly.)

k. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

l. Repeat the whole of Step 1 for all of the transponder registers capable of being serviced.

m. For at least three of the transponder registers set the bits in the CQ Quanta to alternating Ones and Zeros, starting with a ONE (1) in the first bit and repeat Step 1.

n. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 2 – LSB change tests with EC Field = 3

a. Ensure that data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-11 with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above. Also set the sub divided fields in the Change Quanta field (CQ) as in (i) and (ii) below:

(i) When the sub divided field represents a numerical value set it to the least significant bit value.

(ii) When the sub field represents a character or status information set it to ALL ONEs.

<u>Table C-11:</u> MSP Packet on MSP Channel 6 with EC=3

SR=1	DH					MT=0	EC=3	ST=0	CQ Quanta (56 bits) LSB=1 all other bits = 0
	CNS=0	RDS = 1	Spare	BDS1	BDS2				

<u>Note:</u> *When EC=3 the Change Quanta field (CQ) is sub-divided into the same fields as the transponder register with which the contract is being made. For each of these sub-divided fields ALL ZEROs indicates that changes to that parameter are not to be reported and ALL ONEs indicates that any change to that parameter shall be reported. Otherwise the value in the subfield for a parameter shall be the decimal value of the quantum of the minimum change in that parameter, taking any sign bit into account, which has to be reported. The units of the change parameter are the same as the least significant bit of the parameter being monitored. Status and switch bits are treated as separate fields for change field monitoring.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in “b” above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in <u>Table C-7</u>, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, change the parameter by an amount equal to its least significant bit.

g. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in f. above was sent.

h. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in <u>Table C-7</u>, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO (0).

i. Use an interrogation as in <u>Table C-4</u> but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in <u>Step 2 “b”</u> above. Verify that it contains the data that was loaded into that transponder register. (This indicates that the change monitoring is functioning correctly.)

j. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

k. Repeat "f" to "j," this time changing each parameter in turn by an amount equal to its most significant bit.

l. Repeat the whole of Step 2 for all of the transponder registers capable of being serviced.

m. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 3 – MSB change tests with EC Field = 3

a. Ensure that data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-11 with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above. Also set the sub divided fields in the Change Quanta field (CQ) as in (i) and (ii) below:

   (i) When the sub divided field represents a numerical value set it to the least significant bit value.

   (ii) When the sub field represents a character or status information set it to ALL ONEs.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, change the parameter by an amount equal to its most significant bit.

g. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the parameter change in "f" above was sent.

h. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO (0).

i. Use an interrogation as in Table C-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 3 "b" above. Verify that it contains the data that was loaded into that transponder register. (This indicates that the change monitoring is functioning correctly.)

j. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

k. For each parameter in the transponder register in turn, change the parameter by an amount equal to less than its most significant bit.

l. Verify that NO downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder after the parameter change in "i" above was sent. (This indicates that the contract is functioning correctly.)

m. Repeat the whole of Step 3 for all of the transponder registers capable of being serviced.

n. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 4 – Tests with EC Field = 4 (Only report changes above a threshold value)

a. Ensure that data having a value of the least significant bit is being loaded, into all the fields that represent numerical values, into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-12 with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above. Set the sub fields in the Change Quanta (CQ) field to a value equal to a maximum of one quarter of the MSB, or to the LSB, in each case where the field represents a numerical value. Set the CQ field to ALL ONEs where the field represents a character or status information etc. Also set a Threshold value equal to the MSB for all fields that represent a numerical value in the CT Threshold.

Table C-12: MSP Packet on MSP Channel 6 with EC=4

SR=1	DH					MT=0	EC=4	STS=0	CQ Quanta (56 bits)	CT Threshold (56 Bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2					

Note: *When EC=4 the Change Threshold (CT) field is sub-divided into the same subfields as the transponder register with which the contract is being made. For each of these sub-divided fields ALL ZEROs indicates that changes to that parameter are not to be reported. Otherwise the value in the subfield for a* *parameter shall be the decimal value of the threshold for that parameter taking any sign bit into account. Only parameter changes that cross the threshold criterion are reported. The Change Quanta (CQ) field is similarly divided into subfields which indicate that a change will not be reported for that subfield until the parameter has changed by at least the CQ value since the contract was agreed in the case of a first report, or since the last report generated by this contract.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, increment the parameter value every time a surveillance interrogation is sent to the transponder, in steps equal to the value that has been specified for it in the CQ Quanta until the threshold has been crossed by at least four increments, or has reached its maximum value, and perform the actions of "g," "h," "i," and "j" below.

Note: *The reason for crossing the threshold by four increments if possible is to verify that all changes greater that CQ that are above the threshold crossing are reported.*

g. Extract any announced downlink transaction and verify that they are MSP Packets on Downlink MSP channel 3 as in Table C-7, and they contain a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO (0).

h. Use an interrogation as in Table C-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 4 "b" above. Verify that it contains the data that was loaded into that transponder register and that the data is equal to or has exceeded the value set in the threshold for the parameter under test. (This indicates that the change monitoring is functioning correctly.)

i. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

j. Verify that a correct downlink transaction was only received for each parameter increment that gave a value higher than the threshold.

k. Repeat the whole of Step 4 for all of the transponder registers capable of being serviced.

l. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 5 – Tests with EC Field = 5 (Only report changes below a threshold value)

a. Ensure that data having the maximum value is being loaded into all the fields that represent numerical values, into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-13, with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" above, and the subfields in the Change Quanta (CQ) field set to the least significant bit value in each case where the subfield represents a numerical value, and to ALL ONEs where the field represents a character or status information etc. Set a Threshold value equal to the MSB for all fields that represent a numerical value in the CT Threshold.

Table C-13: MSP Packet on MSP Channel 6 with EC=5

SR=1	DH					MT=0	EC=5	STS=0	CQ Quanta (56 bits)	CT Threshold (56 Bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2					

Note: *When EC=5 the Change Threshold field (CT) is divided into the same subfields as the transponder register with which the contract is being made. For each of these subfields ALL ZEROs indicates that changes to that parameter are not to be reported. Otherwise the value in the subfield for a parameter shall be the decimal value of the threshold for that parameter taking any sign bit into account. Only changes in the parameter that are equal to or greater than the CQ Quanta value and are lower than the threshold are reported.*

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, decrement the parameter value every time a surveillance interrogation is sent to the transponder, in steps equal to the value that has been specified in the Dataflash contact request in Step 5 "b" above for it in the CQ Quanta until the threshold has been crossed by at least four decrements, or has reached its minimum value, and perform the actions of "g," "h," "i," and "j" below.

g. Extract any announced downlink transactions and verify that they are MSP Packets on Downlink MSP channel 3 as in Table C-7, and they contain a DH equal to the value in the request interrogation.

h. Use an interrogation as in Table C-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 5 “b” above. Verify that it contains the data that was loaded into that transponder register and that the data is equal to or has gone below the value set in the threshold for the parameter under test. (This indicates that the change monitoring is functioning correctly.)

i. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

j. Verify that a correct downlink transaction was only received for each parameter increment that gave a value lower than the threshold.

k. Repeat the whole of Step 5 for all of the transponder registers capable of being serviced.

l. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

Step 6 – Tests with EC Field = 6 (Only report changes when the threshold is crossed)

a. Ensure that data having a value of at least 4 Quanta below the threshold or the minimum for the parameter, is being loaded into all the fields that represent numerical values, into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-14, with BDS1 and BDS2 codes to set up a contract with the register being loaded in “a” above, and the sub divided fields in the Change Quanta (CQ) field set to the least significant bit value in each case where the field represents a numerical value, and to ALL ONEs where the field represents a character or status information etc. Set a Threshold value equal to the MSB for all fields that represent a numerical value in the CT Threshold.

Table C-14: MSP Packet on MSP Channel 6 with EC=6

SR=1	DH					MT=0	EC=6	ST=0	CQ Quanta (56 bits)	CT Threshold (56 Bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2					

Note: *When EC=6 the Change Threshold field (CT) is sub-divided into the same fields as the transponder register with which the contract is being made. For each of these sub-divided fields ALL ZEROs indicates that changes to that parameter are not to be reported. Otherwise the value in the subfield for a parameter shall be the decimal value of the threshold for that parameter taking any sign bit into account. Only changes in the parameter that are equal to or greater than the CQ Quanta value and cross the threshold in either direction are reported.*

c. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. For each parameter in the transponder register in turn, increment the parameter value every time a surveillance interrogation is sent to the transponder, in steps equal to the value that has been specified in the Dataflash contract request in Step 6 "b" above (in the CQ Quanta) until a downlink transaction is announced in the reply to a surveillance interrogation then perform tests "g," "h," "i," and "j" below.

g. Extract any announced downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ZERO (0).

h. Use an interrogation as in Table C-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 "b" above. Verify that it contains the data that was loaded into that transponder register and that the data has crossed the value set in the threshold for the parameter under test. (This indicates that the change monitoring is functioning correctly.)

i. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

j. Verify that only one downlink transaction was announced and extracted and that it contained the data value for the first increment after the threshold was crossed. (This indicates that the threshold is functioning correctly.)

k. Ensure that data having a value of at least 4 Quanta above the threshold, or the maximum value for the parameter, is being loaded into all the fields that represent numerical values, into one of the installed transponder registers and record the data being loaded into the transponder register.

l. Repeat the whole of Step 6 but decrementing the parameter value in "f" above.

m. Repeat the whole of Step 6 for all of the transponder registers capable of being serviced.

n. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

<u>Step 7 – Single II CodeTests with EC Field = 15 (Cancel all contracts for the II Code in this request regardless of other information in the DH Field)</u>

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame using II code = 1 to the transponder, containing an MSP packet on uplink MSP channel 6 as in <u>Table C-5</u>, with the BDS1 and BDS2 codes set for a contract with a selected transponder register.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in “b” above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in <u>Table C-7</u>, and it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to a value of ONE (1), and the bit in the CR field corresponding to the II code used in “b” above is set to a ONE (1). (This indicates that the new contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat <u>Step 7 “a” to “e”</u> using different BDS1 and BDS2 codes corresponding to registers that are being loaded with data in the interrogations in “b” above until the maximum number of contracts that can be handled by the system under test have been established. If the maximum number of contracts that can be handled exceeds the number of transponder registers being loaded then repeat “a” to “e” above, setting different values in the CNS subfield in the uplink frames in “b” above until the maximum number of contracts is reached.

g. Send a Mode S uplink frame using II code set as in “b” above, to the transponder, containing an MSP packet on uplink MSP channel 6 as in <u>Table C-5</u>, with the BDS1 and BDS2 codes set for a contract with a selected transponder register with the EC field set to a value of 15.

h. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in “g” above was sent.

i. Extract the downlink transaction and close it out by means of a surveillance interrogation sent to the transponder. Verify that it is an MSP packet on Downlink MSP channel 3 as shown in <u>Table C-7</u>, and that it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to 5. (This indicates that all contracts for the II code set in the interrogation at “g” above have been cancelled).

j. Change the data being loaded into the transponder registers that have contracts established such that a Dataflash message would be triggered if a contract currently existed.

k. Verify that no downlink transactions are announced in the replies to surveillance interrogations in the following 30 seconds.

l. Repeat Step “a” to “i” For II codes 2 to 14 inclusive.

Step 8 – Multiple II CodeTests with EC Field = 15 (Cancel all contracts for the II Code in this request regardless of other information in the DH Field

a. Ensure that data is being loaded into the installed transponder registers and record the data being loaded into each transponder registers.

b. Send a Mode S uplink frame using II code = 1 to the transponder, containing an MSP packet on uplink MSP channel 6 as in Table C-5, with the BDS1 and BDS2 codes set for a contract with a selected transponder register.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in “b” above was sent.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to a value of ONE (1) and the bit in the CR field corresponding to the II code used in “b” above is set to a value of ONE (1). (This indicates that the contract was accepted and is active.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 8 “a” to “e” incrementing the II code in the interrogation in “b” above until the maximum number of contracts that can be handled by the system under test have been established. If the maximum number of contracts that can be handled exceeds the number of II codes repeat “a” to “e” above accessing different transponder registers by setting different values the BDS1 and BDS2 subfields in the uplink frames in “b” above until the maximum number of contracts is reached.

g. Send a Mode S uplink frame setting the II code to the same value as in “b” above, to the transponder, containing an MSP packet on uplink MSP channel 6 as shown in Table C-5, with the BDS1 and BDS2 codes set for a contract with a transponder register not contracted for that II code and with the EC field set to a value of 15.

h. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction in “g” above, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in “g” above was sent.

i. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-7 and that it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to 5 and the bit in the CR field corresponding to the II code used in “b” above is set to a ZERO (0). (This indicates that all contracts for the II code set in the interrogation at “g” above have been cancelled).

j. Change the data being loaded into the transponder registers that have contracts established such that a Dataflash message would be triggered if a contract currently existed.

k. Verify that a separate downlink transaction is announced, directed to each II code other than the II code that was used in “b” above, is announced by the transponder in the replies to a surveillance interrogations sent to the transponder in the period after the uplink frame in “g” above was sent. Also verify that no transaction is announced directed to the II code used in “b” above.

l. Extract each downlink transaction and close it out by means of a surveillance interrogation sent to the transponder. Verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-7, and that it contains a DH equal to the value in the request interrogation. Also verify that the CI field is set to 01 and the bit in the CR field corresponding to the II code used in “b” above is set to a ONE (1). (This indicates that all contracts other than those for the II code set in the interrogation at “g” are still in existence and working normally).

m. Repeat Step 8 “a” to “l” using II codes 2 to 14 inclusive in “b” above.

Step 9 – Tests with EC Field set to unassigned values

a. Ensure that data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-15 with BDS1 and BDS2 codes to set up a contract with the register being loaded in “a” above and EC set to 7.

Table C-15: MSP Packet on MSP Channel 6

SR=1	DH					MT=0	EC	ST=0	CF Quanta (56 bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2				

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in “b” above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of 15. (This indicates that the contract was NOT accepted. This is the correct result because the EC is not valid.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat the whole of Step 9 "a" to "e" incrementing the EC by ONE until EC=14.

C.4.8.2.7 Procedure #7: Stable Time (ST) Field tests

(Reference: §C.4.6.7.2)

This Procedure tests the correct functioning of the ST field.

Step 1 – Tests with ST Field

a. Ensure that fixed data is being loaded into one of the installed transponder registers and record the data being loaded into the transponder register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet on uplink MSP channel 6 as in Table C-16 with BDS1 and BDS2 codes to set up a contract with the register being loaded in "a" and ST set to ONE (1).

Table C-16: MSP Packet on MSP Channel 6 with EC=2

SR=1	DH					MT=0	EC=2	ST	CQ Quanta (56 bits)
	CNS=0	RDS = 1	Spare	BDS1	BDS2				

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder no later than 0.1 seconds after the uplink frame in "b" above was sent.

d. Extract the downlink transaction and verify that it is an MSP Packet on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to a value of ONE (1). (This indicates that the new contract was accepted and is active.)

e. Use an interrogation as in Table C-4 but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 "b" above, and with EC = 2. Verify that it contains the data that was loaded into that transponder register for the parameter under test.

f. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

g. Change and record the data being loaded into any parameter of the transponder register by an amount that exceeds the Quanta value specified in the contract, at intervals equal to one quarter of the value in ST.

h. Verify that NO downlink transaction is announced by the transponder in the reply to surveillance interrogations whilst the data is changing as in “g” above.

i. Stop changing the data being loaded into the transponder register and record the register data.

j. Verify that a downlink transaction is announced by the transponder in the reply to a surveillance interrogation sent to the transponder not earlier than a time equal to ST, and no later than time equal to the value of ST plus 0.1 seconds after the data was first changed.

k. Extract all announced downlink transactions and verify that they contain MSP Packets on Downlink MSP channel 3 as in Table C-7, and it contains a DH equal to the value in the request interrogation and the CI field is set to ZERO (0).

l. Use an interrogation as in Table C-4, but with the RR field and RRS subfield set to extract the GICB that was specified in the Dataflash request in Step 1 “b” above. Verify that it contains the same data that was loaded into that transponder register at “i” above. (This indicates that ST is functioning correctly.)

m. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

n. Repeat the “f” to “l” above, for each parameter in the transponder register.

o. Repeat the “a” to “l” above setting values of ST = 2, 4, 8, 12, and 15 seconds in “b” above.

p. Repeat the whole of Step 1 using at least three different transponder registers.

q. Terminate all contracts by the method used in §C.4.8.2.3 Procedure 3 Step 1.

C.4.8.2.8 Procedure #8: Maximum Message Rate

(Reference: §C.4.7.3, & §C.7.4.3)

This Procedure tests that no more than ten Dataflash messages are output in any six seconds period and that waiting messages are queued and announced to the ground with an indication of delay by setting CI = 6 in the response, as soon as the maximum message criterion allows.

Step 1 – Initializing contracts

a. Ensure that NO data is loaded into any of the transponder registers.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-5, on uplink MSP channel 6. With the BDS1 and BDS2 codes of the transponder register with which the contract is intended set into the DH field.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder 0.1 seconds after the uplink frame in “b” above was received by the transponder.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-7, and it contains a DH equal to the value in the request interrogation and a value of 2 in the CI field. (This indicates that the new contract was not accepted.) Also verify that the CR field contains ALL ZEROs. (This indicates that there are no Dataflash contracts in existence.)

Note: *Since RDS=1 in the contract request this test also verifies that the message register content is not sent when CI is not equal to ZERO.*

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Repeat Step 1 requesting a contract for at least two transponder registers

Step 2 – Dataflash Message triggering rate up to six messages per second

a. Ensure that fixed data is being loaded into the installed registers and being updated at a rate faster than the minimum rate specified for each register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-5, on uplink MSP channel 6. With the BDS1 and BDS2 codes of the transponder register with which the contract is intended set into the DH field.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder 0.1 seconds after the uplink frame in “b” above was received by the transponder.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-7, and it contains a DH equal to the value in the request interrogation and a value of ONE (1) in the CI field. (This indicates that the new contract was accepted.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the data in one or more of the registers in order to trigger ten Dataflash messages every six seconds.

g. Verify that downlink transactions, directed to the II code that was used in the requesting transaction, are announced by the transponder in the reply to a surveillance interrogations sent to the transponder 0.1 seconds after the each of the data changes in “e” above were received by the transponder.

h. Extract and closeout the downlink transactions and verify that they are MSP packets on Downlink MSP channel 3 as shown in Table C-7, and they contain a DH equal to the value in the request interrogation and a value of ZERO (0) in the CI field. (This indicates that they are responses to an existing contract.)

Note: *Closeout each downlink transaction by means of a surveillance interrogation to the transponder.*

Step 3 – Dataflash Message triggering rate greater than six messages per second

a. Ensure that fixed data is being loaded into the installed registers and being updated at a rate faster than the minimum rate specified for each register.

b. Send a Mode S uplink frame to the transponder containing an MSP packet as shown in Table C-5, on uplink MSP channel 6 with the BDS1 and BDS2 codes of the transponder register with which the contract is intended set into the DH field.

c. Verify that a downlink transaction, directed to the II code that was used in the requesting transaction, is announced by the transponder in the reply to a surveillance interrogation sent to the transponder 0.1 seconds after the uplink frame in "b" above was received by the transponder.

d. Extract the downlink transaction and verify that it is an MSP packet on Downlink MSP channel 3 as shown in Table C-7, and it contains a DH equal to the value in the request interrogation and a value of ONE (1) in the CI field. (This indicates that the new contract was accepted.)

e. Closeout the downlink transaction by means of a surveillance interrogation to the transponder.

f. Change the data in one or more of the registers in order to trigger more than ten Dataflash messages every six seconds for a period of at least twelve seconds.

g. Verify that downlink transactions, directed to the II code that was used in the requesting transaction are announced by the transponder in the replies to surveillance interrogations sent to the transponder starting 0.1 seconds after the first of the data changes in "f" above were received by the transponder.

h. Extract and closeout all the downlink transactions and verify that they are MSP packets on Downlink MSP channel 3 as shown in Table C-7. Verify that they contain a DH equal to the value in the request interrogation and do not exceed a rate of ten messages in any six seconds period. Verify that messages, which are not delayed due to the Dataflash message limit of ten within six seconds, contain a value of ZERO (0) in the CI field. (This indicates that they are normal responses to an existing contract.) Also verify that Dataflash messages which have been delayed by queuing in order to remain within the limit for Dataflash messages contain a value of 6 in the CI field. (This indicates that the responses to an existing contract which have been delayed due to Dataflash message limit queuing.)

Note: *Closeout each downlink transaction by means of a surveillance interrogation to the transponder*

C.4.8.2.9 Procedure #9: Test of Mode S Subnetwork Version Number and Global Capability Reporting

Extract Register 10_{16}

Verify that:

- Bit 17 - 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

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

C.4.9 Dataflash Installed System Performance

Installed performance shall be consistent with that specified in §C.8, which was verified through bench and environmental tests. However, certain performance parameters may be affected by the physical installation and can only be verified after installation. The installed performance specified below takes this into consideration.

C.4.9.1 Ground Test Procedures

a. Conformity Inspection

(1) Visually inspect the installed equipment or system to determine the use of acceptable workmanship and engineering practices.

(2) Verify that proper mechanical and electrical connections have been made and that the equipment or system has been located and installed in accordance with the manufacturer's recommendations.

b. Test Equipment Required

(1) A means to interrogate the Mode S transponder with surveillance interrogations and decode the resulting replies.

(2) A means to send data to the transponder registers, extract the air initiated messages announced by the transponder, and extract the data from the registers in the transponder accessed by means of the BDS1 and BDS2 codes in interrogations sent to the transponder.

(3) A means to set up, record and monitor Dataflash contracts by interrogating the Mode S transponder.

c. Test Procedure

(1) Input data either directly from aircraft data sources or stimulate the aircraft systems, such that all the declared transponder registers are being updated.

(2) Using the test equipment, extract the appropriate capability reports and verify that the aircraft Mode S system is functioning, and that it can support uplink MSP channel 6, Downlink MSP channel 3, and the appropriate transponder registers are being updated by the aircraft systems.

d. Interference Effects

With the equipment or system energized,

(1) individually operate each of the other electrically operated aircraft equipment and systems to determine that no significant interference effects are present:

(2) evaluate all reasonable combinations of control settings and operating modes.

C.4.10 Implementation Guidelines for Dataflash

C.4.10.1 Overview

Dataflash is a service which announces the availability of information from air-to-ground on an event-triggered basis. This is an efficient means of downlinking information which changes occasionally and unpredictably.

A contract is sent to the airborne application through the Mode S transponder and the ADLP using an uplink Mode S specific protocol (MSP) (MSP 6, SR = 1) as specified in Annex 10 Volume III, Appendix to Chapter 5. This uplink MSP packet contains information specifying the events which should be monitored regarding the changes of data in a transponder register. When the event occurs, this is announced to the ground installation using the AICB protocol.

The ground installation may then request the downlink information which takes the form of a downlink MSP packet on channel 3 constituted of one or two linked Comm-B segments. The second segment is a direct copy of the relevant transponder register specified in the contract.

The ground system with the embedded dataflash application should determine if an aircraft supports the dataflash protocol as follows:

- if bit 25 of transponder register 10_{16} is set to 1, the system will extract transponder register $1D_{16}$, then,
- if bit 6 and bit 31 of transponder register $1D_{16}$ are set to 1, then the aircraft supports the dataflash service.

C.4.10.2 Minimum number of contracts

The minimum number of contracts activated simultaneously that can be supported by the airborne installation should be at least 64. In the case of a software upgrade of existing installations, at least 16 dataflash contracts should be supported.

C.4.10.3 Contract request for a transponder register not serviced by the airborne installation

On the receipt of a dataflash service request, a downlink dataflash message should immediately be announced to the ground regardless of any event criteria. This message is used by the ground system to confirm that the service has been initiated. The message will only consist of one segment. In the case of a service request for an unavailable transponder register, the message sent to the ground should only contain bits 1 to 40 of the downlink message structure with a CI field value of 2. This value will indicate to the ground system that the service request cannot be honored because of the unavailability of the transponder register. The service will then be terminated by the airborne dataflash function, and the ground system should notify the user which has initiated the request that the service request cannot be honored by the airborne installation.

When a transponder register (which was previously supported) becomes unavailable and is currently monitored by a dataflash contract, a downlink dataflash message containing bits 1 to 40 will be sent with a CI field value of 7. This will indicate to the ground that the transponder register is not serviced anymore. The related contract is terminated by the airborne application, and the ground system should notify the user which has initiated the request that the service request has been terminated by the airborne installation. An alternative means for the ground system to detect that the transponder register is not serviced any longer is to analyze the resulting transponder register 10_{16} which will be broadcast by the transponder to indicate to the ground system that transponder register 17_{16} has changed. The Mode S sensor should then extract transponder register 17_{16} and send it to the ground application. The ground application should then analyze the content of this transponder register and should notice that the transponder register monitored by a dataflash contract is no longer supported by the airborne installation.

C.4.10.4 Service continuity in overlapping coverage with radars using the same II code

Depending on the system configuration the following guidance should be taken into account to ensure service continuity in overlapping coverage of radars working with the same II code.

C.4.10.4.1 Radar with the dataflash application embedded in the radar software

For this configuration it is necessary to manage the contract numbers which will be used by each station and to ensure that the same contract number for the same transponder register is not used by another sensor having overlapping coverage and working with the same II code. The reason for this is that a sensor has no means of detecting if a contract it has initialized has been overwritten by another sensor using an identical dataflash header. Also one sensor could terminate a contract because an aircraft is leaving its coverage and no other sensor would know that this contract had been closed. For this reason, no dataflash contract termination should be attempted by either sensor in order to ensure a service continuity.

When two ground stations with overlapping coverage and having the same II code each set up dataflash contracts with the same transponder register for the same aircraft, it is essential to ensure that the contract number is checked by each ground station prior to the closeout of any AICB which is announcing a dataflash message.

C.4.10.4.2 Use of an ATC centre-based dataflash application

The ATC system hosting the dataflash application should manage the distribution of contract numbers for sensors operating with the same II code. This ATC system will also have the global view of the aircraft path within the ATC coverage to either initiate or close dataflash contracts when appropriate. This is the preferred configuration since a central management of the contract numbers is possible which also allows a clean termination of the contracts.

C.4.10.5 Ground management of multiple contracts for the same transponder register

The ground system managing the dataflash application must ensure that when it receives a request from ground applications for several contracts to monitor different parameters, or different threshold criteria, related to the same transponder register for a particular aircraft/II code pair, it assigns a unique contract number for each contract sent to the aircraft.

C.4.10.6 Service termination

There are three ways to terminate a dataflash service (one from the ground initiative, two from the airborne installation):

1. The ground can send an MSP with the ECS field set to 0 which means that the service is to be discontinued by the airborne installation.

2. The airborne installation will terminate the service with no indication to the ground system if any message is not extracted from the transponder by a ground interrogator within 30 seconds following the event specified in the dataflash contract (TZ timer).

3. When the transponder has not been selectively interrogated by a Mode S interrogator with a particular II code for 60 seconds (this is determined by monitoring the IIS subfield in all accepted Mode S interrogations), all dataflash contracts related to that II code will be cancelled with no indication to the ground system.

The termination from the ground initiative is the preferable way to terminate the service since both the ground and the airborne systems terminate the service thanks to a mutually understood data link exchange. This termination should nevertheless not be allowed in certain configurations especially with adjacent sensors (with the dataflash application embedded in the sensor software) working with the same II code as explained in §C.2.1. If the termination of the contract by a ground system is to be exercised, it should also be noticed that the ground system should anticipate the exit of the aircraft from its coverage to send the close-out message.

C.4.10.7 Dataflash request containing multiple contracts

It is possible to merge several contracts into one single dataflash request. If multiple events occur which are related to several contracts of the initial dataflash request, one downlink message for each individual event should be triggered containing the associated transponder register. Each of these downlink messages should use the air initiated protocol.

C.4.10.8 Transponder register data contained in the downlink message

The transponder register data received by the ground system following the extraction of a downlink dataflash message consisting of two segments are the transponder register data at the time of the event. The transponder register data may be up to 1 aerial scan old since the event may occur just after the illumination of the aircraft. Should the end-user need more up-to-date data, the user should use the event announcement to trigger extraction via GICB protocol to get the latest transponder register data.