ETSO-C112f

SECONDARY SURVEILLANCE RADAR MODE S TRANSPONDER

1 Applicability

This ETSO provides the requirements which Secondary Surveillance Radar Mode S Transponder that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 Procedures

2.1 General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 Specific

None.

3 Technical Conditions

3.1 Basic

3.1.1 Minimum Performance Standard

Standards set forth in the EUROCAE ED-73F / RTCA DO-181F, 'Minimum Operational Performance Standards for Secondary Surveillance Radar Mode S Transponders', dated December 2020, as modified by Change 1, dated January 2022, and as amended by Appendix 1 to this ETSO.

3.1.2 Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 Specific

None.

3.2.1 Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in misleading information is a major failure condition.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in a lack of responses to valid interrogations to a degree sufficient to create potential for a missing resolution advisory (RA) is a major failure condition.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in any of the below is a major failure condition:

— replies sent with incorrect timing;
— replies sent with an incorrect altitude;
— transmission of incorrect information to a connected collision avoidance system.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in annunciated loss of function is a minor failure condition.

4 Marking

4.1 General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 Specific

The marking must also include the transponder's functional level and optional additional features as provided in ED-73F, Section 1.4.2.2, as well as minimum peak output power identified by the transponder class as defined in ED-73F, Section 1.4.2.4.

5 Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

[Amdt ETSO/11]
[Amdt ETSO/18]

Appendix 1 to ETSO-C112f — Secondary Surveillance Radar Mode S Transponder Amendment to EUROCAE ED-73F / RTCA DO-181F requirements

Purpose

This Appendix lists the modifications to EUROCAE ED-73F / RTCA DO-181F, 'Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment', as modified by Change 1. To enhance readability, sections of EUROCAE ED-73F / RTCA DO-181F that are modified by Change 1 are shown with the modifications implemented as the baseline text. Text added to modify EUROCAE ED-73F / RTCA DO-181F is underlined. Text to be removed is struck through. In between the sections an ellipsis, '[…]', is introduced to indicate that the rest of the text is unchanged. For easy reading, all cross references are provided to EUROCAE ED-73F sections. Due to the extensive modifications, Section 5.5.8.36 is included as a complete change.

[…]

3.23.1.12.e.(3) Updating of the Data Link Capability Report

The maximum update interval at which Register 10_{16} shall be reloaded with valid data is ≤ 1.0 seconds.

NOTE: *Effectively, Register 10_{16} must be updated every 1.0 seconds or sooner.*

If a particular data field in Register 10_{16} cannot be updated within 8.0 seconds, the data field shall be set to ZERO<u>, with the exception of the following CAS version and capability fields: CAS Extended Version Number (Bit # 43 – 46 or MB Bit # 11 – 14), Hybrid Surveillance Capability (Bit # 69 or MB Bit # 37), CAS RA Capability Enabled (Bit # 70 or MB Bit # 38), and CAS Version (Bit # 71 – 72 or MB Bit # 39 – 40)</u>.

At intervals not exceeding four seconds, the transponder compares the current basic data link capability status with that last reported and if a difference is noted, initiates a revised basic data link capability report by Comm-B broadcast for BDS1=1 and BDS2=0.

The transponder shall initiate, generate and announce the revised basic data link capability report even if the aircraft data link capability is degraded or lost. To support this requirement, the transponder shall set the BDS for the basic data link capability report.

NOTE: *The setting of the BDS code by the transponder ensures that a broadcast change of the capability report will contain the BDS code for all cases of data link failure (e.g. the loss of the transponder data link interface).*

[…]

3.27.1.2 b.(1) Data Link Capability Codes in MB for All Transponder/CAS Systems

The following bits of the Data Link Capability report are allocated to providing information about the CAS system on the aircraft.

Bit #	MB #	Field	Notes
43	11	CAS Extended Version Number	1
44	12		
45	13		
46	14		
48	16	CAS Out of Standby	2
69	37	Hybrid Surveillance Capability	3
70	38	CAS RA Capability Enabled	4
71	39	CAS Version	5
72	40		

Notes:

1. *CAS Extended Version Number will be 0000 for all versions of TCAS. The definition of this field is as follows:*

Bits 43 – 46 'MB' Bits 11 – 14	Meaning
0000	Non-extended version
0001	ACAS Xa version 1
0010	ACAS Xu version 1
0011 – 1111	Reserved for future versions

2. *CAS Out of Standby, Bit 48 ('MB' bit 16), set to ONE (1) indicates that the both the transponder & CAS functions are operational and the transponder is receiving RI=1, 2, or 3 from the CAS unit. Transponders will only receive RI=1 from CAS that are Active CAS of junior status or passive CAS, i.e. CAS with reduced capability that are limited when interacting with other CAS.*

3. *Hybrid Surveillance Capability, Bit 69 ('MB' bit 37), set to ONE (1) indicates capability of Hybrid Surveillance, and set to ZERO (0) indicates that there is no Hybrid Surveillance capability.*

4. *CAS RA Capability Enabled, Bit 70 ('MB' bit 38), is only relevant if CAS Out of Standby is a ONE (1). This field set to ONE (1) indicates that the CAS is currently capable of generating RAs. This field set to ZERO (0) indicates that CAS is not currently capable of generating RAs. In some systems, such as TCAS and ACAS Xa, this means that the system is currently only able to generate TAs. For other systems, such as ACAS Xu, this means that the system is not currently capable of generating Remain Well Clear (RWC) alerting and guidance.*

5. *CAS Version, Bits 71, 72 ('MB' bits 39, 40), are encoded in accordance with the following table. Note that unlike most other fields in a BDS Register, the MSB of this field is the higher numbered bit.*

Bit 72 'MB' Bit 40	Bit 71 'MB' Bit 39	Meaning
0	0	DO-185 (TCAS 6.04A) (ETSO-C119a)
0	1	DO-185A (TCAS 7.0) (ETSO-C119b)
1	0	EUROCAE ED-143 (TCAS 7.1) (ETSO-C119c – TSO-C119e)
1	1	See CAS Extended Version Number

If the transponder / CAS are no longer communicating or if a failure of the CAS system is detected by the transponder, the transponder **shall** set ~~all CAS related bits in the Data Link Capability report~~ <u>CAS Out of Standby</u> (Bit # ~~43, 44, 45, 46,~~ 48~~, 69, 70, 71, & 72~~ or MB Bit # ~~11, 12, 13, 14,~~ 16~~, 37, 38, 39, & 40~~) to ZERO (0).

Interrogators, such as ground based Mode S sensors, learn of the specific data link capabilities on board the aircraft by using the Data Link Capability Report protocol specified in §3.23.1.12 e.

The data bits discussed here reside in the MB field of the Data Link Capability Report. The transponder inserts these bits such that the data appears appropriately in response to a request for Data Link Capability Report when BDS1=1 and BDS2=0. As such, these data bits comprise only a small fraction of the entire Data Link Capability Report which may collate data from multiple sources for transfer in the downlink. Care must be taken to ensure that the data fields discussed in the following paragraphs are not compromised when other sources attempt to update the Data Link Capability Report, and that updating of these bits does not compromise other parts of the Data Link Capability Report.

3.27.1.2 b.(2) Data Link Capability Codes in MB for Systems Loaded Directly by CAS

The following guidance applies to all 'loaded directly by CAS' (as defined in §3.27.f) transponder/CAS.

In this system, the CAS unit will directly provide the data necessary to set all of the CAS related bits in the Data Link Capability Report (Bit # 43, 44, 45, 46, 48, 69, 70, 71, & 72 or MB Bit # 11, 12, 13, 14, 16, 37, 38, 39, & 40). The transponder **shall** set the bits in the Data Link Capability Report as provided by the CAS<u>, except when a failure is detected as specified in §3.27.2.3</u>. None of the other bits in this register are to be affected by the loading of these bits by CAS.

[...]

3.27.2.3 CAS Failure Data Handling

When a CAS failure is detected, the transponder shall perform the following:

- Set RI (see §3.27.1.5) to ZERO.
- Set SL (see §3.18.4.35) to ZERO.
- Set BDS 1,0 bit~~s 11-14,~~ 16~~, 37-40~~ to ZERO.
- Set BDS 0,F and 3,2 through 3,F to ZERO.
- ~~Set BDS E,5 and E,6 to ZERO.~~
- Set BDS 3,0 and 3,1 to zero when the RAT field (§3.27.1.2 ~~c~~<u>a</u>) is ~~ZERO~~<u>ONE</u>.

<u>Notes:</u>

1. *Ways in which the transponder detects a CAS failure include, but are not limited to~~: (a) non-operational CAS (§3.27.1.5); (b)~~ <u>a</u> failure of the CAS/transponder interface (§3.27.2.2). <u>The reception of RI=0 with SL=1 indicates that the CAS is in standby and is not considered to be a failure condition.</u>*

2. *A CAS failure during an active RA will trigger RA termination (RAT=1). The frozen RA report will be retained while RAT=1 and set to ZERO upon RAT expiration.*

[…]

3.31.3 Update Interval

a. The maximum update interval at which a data field in a Register will be reloaded with valid data is defined for each register in Table B-2-1 in Appendix B.

b. The transponder will load valid data into the related transponder Register as soon as it becomes available at the Mode S Specific Services Entity.

c. The time between availability of data that causes a change in a data field of a Register and the time that the change is made to the Register will be less than the maximum update interval specified in Table B-2-1 in Appendix B.

d. If a data field cannot be updated with valid data within twice the specified maximum update interval defined for the Register or 2.6 seconds (whichever is the greater), then Status Bit (if specified) of the field will be set to ZERO (~~‘0’~~ (INVALID) and that data field will be ~~ZERO~~zeroed.

[…]

5.5.8.34 Procedure #30: Sensitivity Level Operation (§3.27.1.5)

This test verifies that the transponder receives sensitivity level information from the CAS unit and correctly reports this information in outgoing DF=0, 16 replies.

Note: *When the following tests are performed with a EUROCAE 143 (or later) transponder/CAS interface, bit=48 of the Data Link Capability Report must be set consistent with the RI field specified for the test (see §3.27.1.2.b).*

a. Send a status = ‘Active CAS with resolution capability’ and a sensitivity level=6 to the transponder via the transponder/CAS interface.

Interrogate the transponder with a UF=0 and a UF=16 non-acquisition interrogation.

Show that the transponder correctly reports the CAS status and sensitivity level in the RI and SL fields respectively.

b. Not used.

c. Not used.

d. Send a sensitivity level=4 to the transponder via the transponder/CAS interface. Interrogate the transponder with a UF=0 and a UF=16 non-acquisition interrogation.

Show that the transponder correctly reports the CAS status and sensitivity level in the RI and SL fields respectively.

e. Send a status = ‘CAS with resolution capability inhibited’ and a sensitivity level=2 to the transponder via the transponder/CAS interface.

Interrogate the transponder with a UF=0 and a UF=16 non-acquisition interrogation.

Show that the transponder correctly reports the CAS status and sensitivity level in the RI and SL fields respectively.

f. Send a status = ‘No operating CAS’ and a sensitivity level=1 to the transponder via the transponder/CAS interface.

Interrogate the transponder with a UF=0 and a UF=16 non-acquisition interrogation.

Show that the transponder correctly reports the CAS status and sensitivity level in the RI and SL fields respectively (RI=0, SL=1).

g. Send a status = 'Active CAS of junior status with resolution capability or Passive CAS with resolution capability' and a sensitivity level=3 to the transponder via the transponder/CAS interface.

Interrogate the transponder with a UF=0 and a UF=16 non-acquisition interrogation.

Show that the transponder correctly reports the CAS status and sensitivity level in the RI and SL fields respectively.

[…]

5.5.8.36.2 Procedure #32: Transmission of CAS Capability Information to a Mode S Sensor (§3.27.g, §3.27.1.2.b, §3.27.1.2.b.1, and §3.27.1.2.b.2) and to other CAS Aircraft (§3.27.1.5) for a Transponder Capable of Being Loaded Directly by CAS

a. Enable the transponder only (i.e. establish the state where the transponder/CAS interface is not operational).

b. Interrogate the transponder with a non-acquisition UF=0 interrogation.

Show that the transponder replies with the correct capability information in the DF=0 reply (i.e. RI=0).

c. Interrogate the transponder with the following four interrogations:

UF=4 with RR=17 and DI≠7;

UF=5 with RR=17 and DI≠7;

UF=20 with RR=17, DI=7, and RRS=0;

UF=21 with RR=17, DI=7, and RRS=0.

Show, in each of the four cases, that the transponder replies with the correct capability information in the DF=20, 21 replies (i.e. BDS1=1, BDS2=0, bits 43 – 46 = 0000, bit 48=0, ~~bits 69, 70, 71 and 72 =0000~~ and bits 69 – 72 = 0000). ~~Additionally show that in each of the four cases bits 43, 44, 45 and 46 = 0000.~~

d. Establish the transponder/CAS interface. Repeat the procedures in steps b and c above for each of the following ~~32~~ cases ~~in substep (1a), (1b), (2a), (2b), (3a), (3b), (4a), and (4b) below~~. For each case use the following values for validating that the CAS version is correctly reported in the Data Link Capability Report:

DO-185A TCAS:	Bits 43 – 46: 0000, Bits 71, 72: 10
DO-185B / ED-143 TCAS:	Bits 43 – 46: 0000, Bits 71, 72: 01
DO-385 / ED-256 ACAS Xa:	Bits 43 – 46: 0001, Bits 71, 72: 11
DO-386 / ED-275 ACAS Xu:	Bits 43 – 46: 0010, Bits 71, 72: 11

(1) CAS reports (RI=2) and reports bit 48=1, bit 69=1 and bit 70=0 in its Data Link Capability Report information to the transponder via the transponder/CAS interface.

Show that the transponder replies with RI=2 in the DF=0 reply.

Show that the transponder replies with bits 43 – 46, 71 and 72 reporting the correct CAS version, bit 48=1, bit 69=1 and bit 70=0 in the DF=20, 21 replies.

(2) CAS reports (RI=3) and reports bit 48=1, bit 69=0 and bit 70=1 in its Data Link Capability Report information to the transponder via the transponder/CAS interface.

Show that the transponder replies with RI=3 in the DF=0 reply.

Show that the transponder replies with bits 43 – 46, 71 and 72 reporting the correct CAS version, bit 48=1, bit 69=0 and bit 70=1 in the DF=20, 21 replies.

(3) CAS reports RI=0 and reports bit 48=0, bit 69=1, and bit 70=0 in its Data Link Capability Report information to the transponder via the transponder/CAS interface.

Show that the transponder replies with RI=0 in the DF=0 reply.

Show that the transponder replies with bits 43 – 46, 71 and 72 reporting the correct CAS version, bit 48=0, bit 69=1 and bit 70=0 in the DF=20, 21 replies.

[...]

5.5.8.37.1 Procedure #33: CAS or transponder/CAS Interface Failure During Transmission of RA Report and Data Link Capability Report to a Mode S Sensor (§3.27.1.2 a (2) and §3.27.1.2 b (2) for a Transponder Operating with an RTCA DO-185A or EUROCAE ED-143 or EUROCAE ED-256 compatible CAS

For each of the CAS versions use the following values to validate that the CAS version is correctly reported in the Data Link Capability Report:

DO-185A TCAS: Bits 43 – 46: 0000 , Bits 71, 72: 10

DO-185B TCAS: Bits 43 – 46: 0000 , Bits 71, 72: 01

ED-256 ACAS Xa: Bits 43 – 46: 0001 , Bits 71, 72: 11

a. Send the following content for the RA report to the transponder via the transponder/CAS interface once per second for 5 seconds.

BDS	Bits 41 – 58	RAI	Bits 60 – 88
48	010101010101010101	0	11001100110011001100110011001

During the 5th second, cause the CAS unit to report a CAS failure to the transponder ~~(i.e. RI=0 and SL=1)~~.

Interrogate the transponder once per second during the 5 seconds described above and for an additional 25 seconds (30 seconds total) with UF=4 interrogations with RR=19, DI=7, and RRS=0 and with UF=4 interrogations with RR=19, DI=7, and RRS=1.

Show that in the DF=20 RA report replies:

For the first 23 ±1 seconds, the ~~'ACAS Resolution report available code'~~ 'TCAS bit' is set in the DR field. Thereafter, it is cleared.

For the first 5 seconds, the RA Report has the following content:

BDS	Bits 41 – 58	RAT	Bits 60 – 88
48	Same as input	0	Same as input

BDS	Bits 41 – 88
49	0

For the next 18 ±1 seconds, the content is:

BDS	Bits 41 – 58	RAT	Bits 60 – 88
48	Same as input	1	Same as input

BDS	Bits 41 – 88
49	0

For the remaining 7 ±1 seconds, the values are:

BDS	Bits 41 – 58	RAT	Bits 60 – 88
48	000000000000000000	0	00000000000000000000000000000

BDS	Bits 41 – 88
49	0

b. Repeat the steps in step 'a', except during the 5th second, cause the transponder to recognize a failure on the transponder/CAS interface (i.e. disconnect or otherwise interrupt the interface). The results should be the same as in step 'a'.

c. Send 'Active CAS with resolution capability' (RI=3), CA operational = 1, hybrid surveillance capability, and the CAS version to the transponder via the transponder/CAS interface for 5 seconds.

During the 5th second, cause the ~~transponder to recognize a failure on the transponder/CAS interface (i.e. disconnect or otherwise interrupt the interface)~~ CAS unit to report a CAS failure to the transponder.

Interrogate the transponder once per second for 30 seconds with UF=4 interrogations with RR=17, DI 7 and RRS=0.

Show that in the DF=20 Data Capability Report replies:

For the first 5 seconds, bits 43, 44, 45, 46, 71 and 72 indicate the correct CAS version, bit 48=1, bit 69=1, and bit 70=1.

For the next 25 seconds, ~~bits 43, 44, 45, 46, 48, 69, 70, 71, and 72 all = 0~~ bits 43 – 46, 71 and 72 indicate the correct CAS version, bit 48=0, bit 69=1 and bit 70=1.

d. Repeat steps a., b. and c., this time using the following content as input:

BDS	Bits 41 – 58	RAI	Bits 60 – 88
48	101010101010101010	0	00110011001100110011001100110

The results should be the same as in test steps a., b. and c.

5.5.8.37.2 Procedure #33: CAS or transponder/CAS Interface Failure During Transmission of RA Report and Data Link Capability Report to a Mode S Sensor (§3.27.1.2 a (2) and §3.27.1.2 b (2)) for a Transponder Operating with an EUROCAE ED-275/RTCA DO-386 Compatible ACAS Xu

a. Send the following content for the RA report to the transponder via the transponder/CAS interface once per second for 5 seconds:

Part 1 of RA report: Content for BDS register 30_{16}

BDS	Bits 41 – 58	RAI	Bits 60 – 88
48	010101010101010101	0	11001100110011001100110011001

Part 2 of RA report: Content for BDS register 31_{16}

BDS	Bits 41 – 88
49	000111000111000111000111000111000111000111000111

During the 5th second, cause the CAS unit to report a CAS failure to the transponder ~~(i.e. RI=0 and SL=1)~~.

Interrogate the transponder once per second during the 5 seconds described above and for an additional 25 seconds (30 seconds total) with UF=4 interrogations with RR=19, DI=7, and RRS=0 and with UF=4 interrogations with RR=19, DI=7, and RRS=1.

Show that in the DF=20 RA report replies:

For the first 23 ±1 seconds, the ~~'ACAS Resolution report available code'~~ ‘TCAS bit’ is set in the DR field. Thereafter, it is cleared.

For the first 5 seconds, the RA Report has the following content:

BDS	Bits 41 – 58	RAT	Bits 60 – 88
48	Same as input	0	Same as input

BDS	Bits 41 – 88
49	Same as input

For the next 18 ±1 seconds, the content is:

BDS	Bits 41 – 58	RAT	Bits 60 – 88
48	Same as input	1	Same as input

BDS	Bits 41 – 88
49	Same as input

For the remaining 7 ±1 seconds, the values are:

BDS	Bits 41 – 58	RAT	Bits 60 – 88
48	000000000000000000	0	00000000000000000000000000000

BDS	Bits 41 – 88
49	000000000000000000000000000000000000000000000000

b. Repeat the steps in step ‘a’, except during the 5th second, cause the transponder to recognize a failure on the transponder/CAS interface (i.e. disconnect or otherwise interrupt the interface). The results should be the same as in step ‘a’.

c. Send ‘Active CAS with resolution capability’ (RI=3), CA operational = 1, ~~no~~ hybrid surveillance capability, and CAS of ACAS Xu version 1 to the transponder via the transponder/CAS interface for 5 seconds.

During the 5th second, cause the ~~transponder to recognize a failure on the transponder/CAS interface (i.e. disconnect or otherwise interrupt the interface)~~ CAS unit to report a CAS failure to the transponder.

Interrogate the transponder once per second for 30 seconds with UF=4 interrogations with RR=17 and DI=7.

Show that in the DF=20 Data Capability Report replies:

For the first 5 seconds, bits 43, 44, 45, and 46 ~~are~~ =‘0010’, bit 48=1, and bits 69, 70, 71, and 72=’1111’.

For the next 25 seconds, ~~bits 43, 44, 45, 46, 48, 69, 70, 71, and 72 all = 0~~ bits 43 – 46=’0010’, bit 48=0, and bits 69 – 72=’1111’.

d. Repeat steps a., b. and c., this time using the following content as input:

Part 1 of RA report: Content for BDS register 30_{16}

BDS	Bits 41 – 58	RAI	Bits 60 – 88
48	101010101010101010	0	00110011001100110011001100110

Part 2 of RA report: Content for BDS register 31_{16}

BDS	Bits 41 – 88
49	111000111000111000111000111000111000111000111000

The results should be the same as in test steps a., b. and c.

[…]

5.8 Generic Register XX Test Procedures (§3.31)

Introduction:

The following general test procedure is intended to provide guidelines for minimal verification that newly implemented GICB registers are properly being serviced. This test procedure is not intended for Extended Squitter registers; tests for Extended Squitter are included in EUROCAE ED-102B as modified by Change 1.

5.8.1 Purpose and Definition (§3.31.1)

NOTE: *In the following subsections, ‘**ddd**’ means the decimal equivalent to **XX**$_{16}$. For instance, for 40_{16}, ‘**ddd**’ = 64_{10} = 64.*

For any newly added given Register **XX**$_{16}$, refer to Appendix B, Table B-3-**ddd** for appropriate format and definition of the register.

5.8.2 Data Requirement (§3.31.2)

a. Ensure that no data is being provided to the transponder that could be used to fill any field in the Register **XX**$_{16}$ that is being tested.

b. Interrogate the transponder using GICB protocols as specified in §3.23.1.12.

NOTE 1: *See §5.7.7.1.a and b as example interrogations used to extract Register 60_{16}.*

c. Verify that the transponder replies with a DF=20 reply with all externally provided data in Bits 33 through 88 (bits 1 through 56 of the ‘MB’ field) set to ALL ZERO (0).

NOTE 2: *Some registers are required to fill bits 1 through 8 with the Register Number, e.g. **XX**$_{16}$. In such cases, bits 1 through 8 of the ‘MB’ field will contain the Register number **XX**$_{16}$ and the remaining bits (9 through 56) of the ‘MB’ field will be set to ZERO (0).*

5.8.2.1 Data Field ‘y’ (§3.31.2.1)

a. Via an appropriate interface, provide the transponder with appropriate valid data for each parameter ‘**y**’ in Register **XX**$_{16}$ that is to be tested.

b. Interrogate the transponder using GICB protocols as ~~specified~~ described in §3.23.1.12.

NOTE: *See §5.7.7.1.a and b as example interrogations used to extract Register 60_{16}.*

c. For each ‘**y**’ parameter, verify that the transponder replies with an ‘MB’ field having:

(1). Each ‘**y**’ parameter encoded in the proper register location.

(2). Each ‘**y**’ parameter encoded in two’s complement arithmetic unless otherwise specified.

(3). Each ‘**y**’ parameter value properly rounded to preserve accuracy of ±½ LSB.

(4). Status bit for each applicable ‘**y**’ parameter set to ONE (1) if data is valid and set to ZERO (0) if data is invalid.

5.8.3 Update Rate (§3.31.3)

Change the data provided to the transponder and repeat the interrogation given in §5.8.2.1.b as necessary to complete the following steps:

a. For each ‘**y**’ parameter, verify that the data changes to the appropriate value required in §5.8.2.1.c within the maximum update interval time specified in Appendix B, Table B-2-1 for the given Register **XX**$_{16}$ being tested.

b. If the appropriate value required in ‘a’ above cannot be realized within twice the maximum update interval time specified or ~~2~~ 2.6 seconds (whichever is greater), verify that the parameter ‘**y**’ subfield and its associated status bit is set to ALL ZERO (0).

5.8.4 Service Reporting (§3.31.4)

Change the data provided to the transponder and repeat the interrogation given in §5.8.2.1.b as necessary to complete the following steps:

a. Verify that the servicing of Register **XX**$_{16}$ during the power-on cycle of the transponder is properly reported in Registers 18_{16} through $1C_{16}$ as required in Appendix B, Table B-3-24 to Table B-3-28.

b. Verify that the real-time (not just since power-on) servicing of Register **XX**$_{16}$ is properly reported in Register 17_{16} (see Appendix B, Table B-3-23) if such reporting is required for Register **XX**$_{16}$.

c. Verify that an appropriate Comm. – B Broadcast is initiated if a change to Register **XX**$_{16}$ forces a change to Register 10_{16}.

Note: *See §5.7.7.2.b.(2) as an example of validating presence of the Broadcast using Register 60_{16}.*

d. Extract the Broadcast and verify that the contents of Register 10_{16} have been changed in accordance with the change action affecting Register **XX**$_{16}$ under test.

Note: *See §5.7.7.2.g as an example of validating the Broadcast using Register 60_{16} as the register forcing the change to Register 10_{16}.*

5.8.5 Register XX$_{16}$ – Repeat §5.8.1 through §5.8.4 using Extended Data Source Extraction with ‘DI’ = 3 (§3.31)

Note: *The following procedure uses XY to define the register as opposed to XX used in §5.8.*

Repeat all of §5.8.1 through §5.8.4 using the following interrogation.

Register XY$_{16}$ GICB extraction Extended data source interrogation setup using DI=3							
1 ---- 5	6 ---- 8	9 --- 13	14 - 16	17 -- 22	23	24 – 27	28 – 32
				‘SD’			

'UF' =	'PC' =	'RR' =	'DI' =	'SIS' =	'LSS' =	'RRS' =	Not Assigned =
4	**0**	**16 + X** (1X HEX)	**3**	**1**	**1**	**Y** (Y HEX)	**0**

[…]

APPENDIX B

[…]

Table B-2-1: GICB Register Number Assignments

Transponder Register Number	*Assignment*	*Implementation Reference*	*Maximum update interval* (Note 1)
00_{16}	Not valid	Not defined as a specific register, however corresponding protocol used to extract AICB and Comm-B Broadcast on Level 2	N/A
01_{16}	Reserved		N/A
02_{16}	Linked Comm-B, segment 2	Level 2 with AICB Capability	N/A
03_{16}	Linked Comm-B, segment 3	Level 2 with AICB Capability	N/A
04_{16}	Linked Comm-B, segment 4	Level 2 with AICB Capability	N/A
05_{16}	Extended Squitter Airborne Position	ADS-B ([6])	0.2s
06_{16}	Extended Squitter Surface Position	ADS-B (6)	0.2s
07_{16}	Reserved (Removed from subnetwork version number 6)	ADS-B v0 – v2 (6)	N/A
08_{16}	Extended Squitter Identification and Category	ADS-B (3, 6)	15.0s
09_{16}	Extended Squitter Airborne Velocity	ADS-B (6)	1.3s
$0A_{16}$	Reserved (Removed from ADS-B v3)	ADS-B v1 and v2 (6) transmission of 61_{16}. Not for direct reading (2).	N/A
$0B_{16}$ – $0C_{16}$	Reserved (Removed from subnetwork version number 6)		N/A
$0D_{16}$ – $0E_{16}$	Reserved		N/A
$0F_{16}$	Reserved for CAS		N/A
10_{16}	Data Link Capability Report	Level 2	<u>≤</u>4.0s <u>(7)</u>
11_{16}	Data Link Capability Report (extension)	Level 2 with Basic Dataflash	5.0s
12_{16} – 16_{16}	Reserved for extension to datalink capability reports		5.0s
17_{16}	Common usage GICB Capability Report	Level 2	5.0s

Transponder Register Number	Assignment	Implementation Reference	Maximum update interval (Note 1)
$18_{16} – 1C_{16}$	Mode S Specific Services Capability Reports (GICB Capability)	Level 2	5.0s
$1D_{16} – 1F_{16}$	Mode S Specific Services Capability Reports (MSP Capability)	Level 2	5.0s
20_{16}	Aircraft Identification	Level 2	5.0s
21_{16}	Aircraft and airline registration markings		15.0s
22_{16}	Reserved (Removed from subnetwork version number 6)		N/A
$23_{16} – 24_{16}$	Reserved		N/A
25_{16}	Aircraft type		15.0s
$26_{16} – 2F_{16}$	Reserved		N/A
30_{16}	CAS Active Resolution Advisory	Level 2 with CAS	1.0s (when RA active)
31_{16}	CAS Active Resolution Advisory (Part 2)		1.0s
32_{16}	Reserved for CAS		N/A
$33_{16} – 37_{16}$	Extended Squitter Operational Coordination Message		1.0s (when RA active)
$38_{16} – 3F_{16}$	Reserved for CAS		N/A
40_{16}	Selected vertical intention	EHS (5)	1.0s
41_{16}	Next waypoint identifier		1.0s
42_{16}	Next waypoint position		1.0s
43_{16}	Next waypoint information		0.5s
$44_{16} – 45_{16}$	Reserved (Removed from subnetwork version number 6)		N/A
$46_{16} – 47_{16}$	Reserved		N/A
48_{16}	VHF channel report		5.0s
$49_{16} – 4F_{16}$	Reserved		N/A
50_{16}	Track and turn report	EHS (5)	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
$57_{16} – 5E_{16}$	Reserved		N/A
$5F_{16}$	Reserved (Removed from subnetwork version number 6)		N/A
60_{16}	Heading and speed report	EHS (5)	1.3s
61_{16}	Extended Squitter Aircraft Status (Subtype 1: Emergency/Priority Status)	ADS-B v1 – v3 (6)	15.0s
62_{16}	Extended Squitter Target State and Status Information	ADS-B v1 – v3 (6)	0.5
63_{16}	Extended Squitter Aircraft Status (Subtype 4: UAS/RPAS Lost Link, Current TCP)	ADS-B v3 (6)	1.0s

Transponder Register Number	Assignment	Implementation Reference	Maximum update interval (Note 1)
64_{16}	Extended Squitter Aircraft Status (Subtype 4: UAS/RPAS Lost Link, Next TCP)	ADS-B v3 (6)	1.0s
65_{16}	Extended Squitter Aircraft Operational Status	ADS-B v1 – v3 (6)	2.5 s
66_{16}	IRM – Interrogation Rate Monitor	ADS-B v3 (6)	5.0s
67_{16}	IRM – Reply Rate Monitor	ADS-B v3 (6)	5.0s
68_{16}	ADS-B Wx AIREP (Subtype 0: Aircraft State)	ADS-B v3 (6)	60 s
69_{16}	ADS-B Wx AIREP (Subtype 1: Weather State)	ADS-B v3 (6)	5.0 s
$6A_{16}$	ADS-B Wx AIREP (Subtype 2: Alternate Weather State)	EHS (5) and ADS-B v3 (6)	5.0 s
$6B_{16}$	ADS-B Wx PIREP (Subtype 0: Flight Weather)	ADS-B v3 (6)	Indefinite
$6C_{16}$	ADS-B Wx PIREP (Subtype 1: Temp, Wind & Turbulence)	ADS-B v3 (6)	Indefinite
$6D_{16}$	ADS-B Wx PIREP (Subtype 2: Hazardous Weather)	ADS-B v3 (6)	Indefinite
$6E_{16}$	High Velocity and/or Altitude (Subtype 0: Position)	ADS-B v3 (6)	0.2s
$6F_{16}$	High Velocity and/or Altitude (Subtype 1: Velocity)	ADS-B v3 (6)	0.2s
70_{16}	Reserved		N/A
71_{16}	Interval Management Report	EHS (5) and IM (4)	10 s
72_{16} – DD_{16}	Reserved		N/A
DE_{16} – DF_{16}	Mode S BITE	ICAO Doc 9871 and Doc 9924	N/A
$E0_{16}$	Reserved		N/A
$E1_{16}$ – $E2_{16}$	Mode S BITE	ICAO Doc 9871 and Doc 9924	N/A
$E3_{16}$	Transponder type/part number	Recommended in European CS-ACNS AMC1 ACNS.D.ELS.015	15 s
$E4_{16}$	Transponder software revision number	Recommended in European CS-ACNS AMC1 ACNS.D.ELS.015	15 s
$E5_{16}$	CAS unit part number	Level 2 with CAS	~~15 s~~ Indefinite
$E6_{16}$	CAS unit software revision number	Level 2 with CAS	~~15 s~~ Indefinite
$E7_{16}$	Transponder Status and Diagnostics		15 s
$E8_{16}$ – $E9_{16}$	Reserved		N/A
EA_{16}	Vendor Specific Status and Diagnostics		15 s
EB_{16} – $F0_{16}$	Reserved		N/A
$F1_{16}$ – $F2_{16}$	Reserved (Removed from subnetwork version number 6)		N/A
$F3_{16}$ – FF_{16}	Reserved		N/A

***NOTES** for Table B-2-1:*

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 Register $0A_{16}$ is not to be used for GICB or ACAS crosslink readout.

3 If Extended Squitter is implemented, then Register 08_{16} is not cleared or ZEROed once either Flight Identification or Aircraft Registration data has been loaded into the Register during the current power-on cycle. Register 08_{16} is not cleared since it provides information that is fundamental to track file management in the ADS-B environment. (See §2.2.5.1.11.c in RTCA DO-260C / EUROCAE ED-102B).

4 The maximum update interval of register 71_{16} is used to determine if new IM data is provided and when the IM data has to be reset. An empty message will be sent every 10s by the Flight-deck Interval Management (FIM) application, the reception of this message is sufficient for the transponder to declare support for the Interval Management Report in BDS 1,A and 1,7. When an IM clearance is active the FIM application will send the data every 1s for a limited period of time, as defined in DO-361A/ED-236A.

5 The EHS (Enhanced Surveillance) parameters are defined in European Union regulation and in ICAO Doc 7030. ~~EU 1207/2011~~Commission Implementing Regulation (EU) 2023/1770 requires the transmission of parameters. CS-ACNS indicates which registers shall or should be transmitted. ~~EU 1207/2011 requires that any information transmitted must be tested.~~

6 ADS-B requirements are defined by state regulations including but not limited to U.S. 14 CFR 91.225 and 91.227, European Commission Implementing Regulation ~~(EU) 1207/2011, (EU) 1028/2014, (EU) 2017/386, (EU) 2020/587~~(EU) 2023/1770 and associated CS-ACNS, Canadian Operations Specifications 609 for domestic or 610 for foreign operators and Advisory Circular AC700-009 revision 2, Australian CAO 20.18, 82.1, 82.3, 83.5, and Advisory Circular AC-21-45(v2.2).

7 A CAS compatible transponder populates the following CAS version and capability fields of Register 10_{16} as corresponding data is received by the CAS: CAS Extended Version Number (Bit # 43 – 46 or MB Bit # 11 – 14), Hybrid Surveillance Capability (Bit # 69 or MB Bit # 37), CAS RA Capability Enabled (Bit # 70 or MB Bit # 38), and CAS Version (Bit # 71 – 72 or MB Bit # 39 – 40). Once populated with non-zero data, these fields are not cleared or ZEROed during the current power cycle.5 The EHS (Enhanced Surveillance) parameters are defined in European Union regulation and in ICAO Doc 7030. ~~EU 1207/2011~~Commission Implementing Regulation (EU) 2023/1770 requires the transmission of parameters. CS-ACNS indicates which registers shall or should be transmitted. ~~EU 1207/2011 requires that any information transmitted must be tested.~~

[…]

Table B-3-17: BDS Code 1,1 — Data Link Capability Report (extension)

MB FIELD

1	MSB
2	
3	
4	
5	BDS Code 1,1 (11_{16})
6	
7	
8	LSB

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

1) See Table B-3-16a (BDS 1,0) Note 7.

2) Encoding of Monitoring bits for each Basic Dataflash Register shall be encoded as follows:

9	Continuation flag (see 6)	
10	Reserved	
11	MSB	BDS 4,0 (40_{16}) Selected Vertical Intent change
12	LSB	(see 2)
13	MSB	Reserved for future Basic Dataflash Register Expansion
14	LSB	(see 2)
15	MSB	Reserved for future Basic Dataflash Register Expansion
16	LSB	(see 2)
17	MSB	Reserved for future Basic Dataflash Register Expansion
18	LSB	(see 2)
19	MSB	BDS 4,8 (48_{16}) VHF Channel Report change
20	LSB	(see 2)
21	MSB	Reserved for future Basic Dataflash Register Expansion
22	LSB	(see 2)
23	MSB	Reserved for future Basic Dataflash Register Expansion
24	LSB	(see 2)
25	MSB	Reserved for future Basic Dataflash Register Expansion
26	LSB	(see 2)
27	MSB	BDS 7,1 (71_{16}) Interval Management Report
28	LSB	(see 2)
29	MSB	Reserved for future Basic Dataflash Register Expansion
30	LSB	(see 2)
31	MSB	Reserved for future Basic Dataflash Register Expansion
32	LSB	(see 2)
33	MSB	Reserved for future Basic Dataflash Register Expansion
34	LSB	(see 2)
35	MSB	Reserved for future Basic Dataflash Register Expansion
36	LSB	(see 2)
37–40	Reserved (see 3)	
41	MSB	
42–55	Bit array indicating the support status of DTE 48 Sub-addresses 0 to 15 (see 4 and 5)	
56	LSB	

Monitoring Bit Encoding		
MSB	**LSB**	**Meaning**
0	0	Register is NOT monitored. (see §3.32.3.a and §3.32.4.f).
0	1	Register is monitored but there has been no update change in the register contents ~~since the last time that the register was included in a Basic Dataflash Broadcast~~. (see §3.32.3.b).
1	0	Register is monitored and data contents are changing such that the Monitoring Bits shall be toggled '10', '11', '10', etc., each time the contents change in accordance with §3.32.4.b. through §3.32.4.e.
1	1	

3) These bits remain reserved for future system expansion needs.

4) Starting from the MSB, each subsequent bit position **shall** represent the DTE sub-address in the range of 0 to 15.

5) 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.

6) 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 can be extracted by the interrogator. For example: upon detection of bit 9 = 1 in register 10_{16}, then register 11_{16} can be extracted by the interrogator. If bit 9 = 1, in register 11_{16}, then register 12_{16} can be extracted by the interrogator, and so on (up to register 16_{16}). Note that if bit 9 = 1 in register 16_{16}, then this is considered as an error condition

[Amdt ETSO/11]
[Amdt ETSO/18]