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ATCRBS / Mode S Transponder MOPS Maintenance

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Register 08₁₆ and 20₁₆ Timeout Issues

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SUMMARY

This Working Paper is in response to an original email produced by Kevin Wilson of Honeywell as a question related to the timeouts of Registers 08₁₆ and 20₁₆. The basic issue surfaced by the email is that Register 20₁₆ is cleared upon loss of data while Register 08₁₆ is not cleared in all cases. There are reasons for this, which based on the history of the definition and use of the two Registers is discussed in the following paper.

REGISTER 08₁₆ AND 20₁₆ TIMEOUT ISSUES

Introduction:

The email which follows this discussion was received in regards to issues with data termination and register timeout differences between register 08₁₆ and 20₁₆. The email section is then followed by the appropriate applicable requirements sections taken from:

- a. RTCA DO-181D, Main Body
- b. RTCA DO-260B, Main Body
- c. ARINC 718A, Attachment 3A-1
- d. ICAO Doc. 9871, and
- e. RTCA DO-181D, Appendix B.

Problem Discussion:

The basic issue surfaced by the email is that Register 20₁₆ is cleared upon loss of data while Register 08₁₆ is not cleared in all cases. There are reasons for this which based on the history of the definition and use of the two registers is discussed in the following paragraphs.

a. Register 20₁₆

First, Register 20₁₆ is intended for Elementary Surveillance and is one of the original registers defined in the MOPS for Mode-S Transponders. Remember that the only registers specifically defined in early MOPS were Register 10₁₆, Data Link Capability Report, and Register 20₁₆, Flight Identification. A third register was then added as fundamental Register when TCAS came along and that was Register 30₁₆, TCAS RA Report. All of the other registers were then defined first in the Manual of Mode-S Specific Services (ICAO Doc. 9688) and some earlier working papers. As such, Register 20₁₆ was defined and implemented for many years prior to the advent of Extended Squitter (later becoming ADS-B) and Register 08₁₆.

With the premises of the previous paragraph in mind, Register 20₁₆ was intended primarily for Air Traffic Management by the various Air Navigation Service Providers. The requirements provided in RTCA DO-181D are completely consistent with the intent of the SARPs as presented in the Manual of Mode S Specific Services (Doc. 9688), later in ICAO Annex 10_Volume III_Chapter 5_Appendix, and now in ICAO Doc. 9871 and RTCA DO-181D. Likewise, the requirements are consistent with those entered into ARINC 718A with those requirements predominantly being driven by myself and the then Chairman of Eurocae WG-49.

Now, when one reviews the requirements for Register 20₁₆ to be cleared, it is obvious that the intent was to clear the Register within 10 seconds as required in RTCA DO-181D section 2.2.24.6.3, ICAO Doc. 9871 Table A.2.1 and section A.2.1.1, and RTCA DO-181D Appendix B Table B.2.1 and section B.2.1. More specifically, ARINC 718A Attachment 3A-1 Note 13.c requires that Register 20₁₆ be cleared if Flight Identification data is lost. This requirement was made such that the ground station was specifically advised that Flight Identification data was lost. Remember that when the data is lost, the transponder is required to change the Register, change the setting in the Data Link Capability Report and to establish a Comm.-B Broadcast for 18 +/-1 seconds in order to announce the change to the ground station.

Ok, so the intent was always to clear Register 20₁₆ as provided in the requirements. That brings us to the problem induced in regards to Register 08₁₆ in the note provided in DO-181D section 2.2.24.6.2.1. This problem is discussed in the following subsection "b".

b. Register 08₁₆

ICAO Doc. 9871 Table A.2.1 clearly specifies a timeout of 15.0 seconds for Register 08₁₆. Section A.2.1.1 then specifies that the data should be ZEROed after a period of twice the timeout specified. In other words, Register 08₁₆ should be ZEROed after 30 seconds.

RTCA DO-181D, Appendix B, Table B.2.1 and section B.2.1 then provide the same requirements as discussed in the previous paragraph.

Likewise, RTCA DO-260B Appendix A, Table A-1 and Section A.1.2 provide the same requirement as discussed in the last two paragraphs.

However, conflict is first evidenced with ICAO Doc. 9871 Appendix A, section A.2.4.2 then indicating in a note that Register 08₁₆ should not be cleared.

Likewise, RTCA DO-260B, Appendix A, section A.1.5.2.d provides the same indication in a note that Register 08₁₆ should not be cleared. This requirement is then specifically stated in RTCA DO-260B section 2.2.3.3.2.11.

As such, Appendix A of ICAO Doc. 9871 has a note that conflicts with the requirements given in Table A.2.1 and section A.2.1.1 of the same document.

Likewise, Appendix A of RTCA DO-260B section A.1.5.2.d has a note that conflicts with the requirements given in Table A-1 and Section A.1.2 of the same document.

Clearly, the drivers of Appendix A in ICAO Doc. 9871 and RTCA DO-260B intended that Register 08₁₆ not be cleared. The probable reasoning for this is that Register 08₁₆ is intended to provide Flight Identification in the ADS-B environment and such Flight Identification is subsequently used to do report tagging or track file management in the ADS-B environment.

Recommendations and Conclusion:

OK, there is conflict in the requirements as discussed above. Moving on by establishing the following premises:

1. Register **20₁₆** is intended for use by the Air Traffic Management providers, is a part of Elementary Surveillance, and is intended to be **CLEARED** as specified in the requirements discussed herein.
2. Register **08₁₆** is intended for ADS-B Surveillance, is a fundamental part of the ADS-B track file management, and is intended to **NOT BE CLEARED** as specified in the requirements discussed herein.

Now, to make that happen, the following changes need to be made in the various applicable documents:

A. In RTCA DO-181D:

1. Change the first note in section 2.2.24.6.2.1 to read as follows:

Note: *Aircraft Registration Data may also be used in Register 08₁₆ when Extended Squitter is implemented. As such, the **Data Selection** requirements inferred below will also apply to Register 08₁₆ when Extended Squitter is implemented.*

2. Add the following note directly after section 2.2.24.6.2.1.c.

Note: *Register 08₁₆ is not cleared when Extended Squitter is implemented since this Register is used to provide Flight Identification information for the ADS-B environment.*

3. Add the following note directly after section B.2.1 of Appendix B.

Note: *If Extended Squitter is implemented, then Register 08₁₆ 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 08₁₆ is **not** cleared since it provides information that is fundamental to track file management in the ADS-B environment.*

B. In ICAO Doc. 9871:

1. Add the following note directly after section A.2.1.1 of Appendix A.

Note: *If Extended Squitter is implemented, then Register 08₁₆ 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 08₁₆ is **not** cleared since it provides information that is fundamental to track file management in the ADS-B environment.*

C. In RTCA DO-260B:

1. Add the following note directly after the last paragraph of section A.1.2 of Appendix A.

Note: *If Extended Squitter is implemented, then Register 08₁₆ 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 08₁₆ is **not** cleared since it provides information that is fundamental to track file management in the ADS-B environment.*

D. In ARINC 718A Supplement 3:

1. Change Attachment 3A-1, Note 13.c to read as follows:

“c. **If Extended Squitter is not implemented, then if flight identification data has been entered into registers 08_{HEX} and 20_{HEX} and then becomes not available, then the character subfields of the registers should all be set to “0”.**

If Extended Squitter is implemented, then if flight identification data has been entered into register 20_{HEX} and then becomes not available, then the character subfields of the register should all be set to “0”.

*If Extended Squitter is implemented, then Register 08_{HEX} 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_{HEX} is **not** cleared since it provides information that is fundamental to track file management in the ADS-B environment.*

Note that Aircraft Registration Data must not be used to fill the character subfields of the registers once flight identification data has been used during the transponder power-on cycle.”

Last, the alternative exists to change the requirements such that Register 08₁₆ is cleared at the same time as Register 20₁₆ is cleared. This alternative is not considered to be viable as it would then defeat the purpose of providing the ADS-B environment with Flight Identification information which is used by ADS-B to establish track file management in the operational environment.

This concludes review and recommendations in regard to the identified Register 08₁₆ and 20₁₆ conflicts. Members of the ICAO ASP TSG, RTCA SC-209, and EUROCAE WG-49 are invited to review the discussion and recommendations and come to appropriate conclusion as to how to resolve the conflict.

Best Regards,

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Email Received Regarding Registers 08₁₆ and 20₁₆:

To: Gary CTR Furr/ACT/CNTR/FAA
From: "Wilson, Kevin (CNS COE)" <kevin.s.wilson@honeywell.com>
Date: 05/06/2010 04:53PM
Subject: DO-260B / DO-181D issue

Gary,

Here's another one for you:

DO-181D (2.2.24.6.3.b) has specific requirements to zero the 20h register after a 10 second timeout.

However, 08h has no specific requirements and conflicting notes. The Note in DO-181D (2.2.23.1.4.2) says that 08h should not be cleared on timeout. But the Note in DO-181D (2.2.24.6.2.1) says that following requirements (for 20h) should also apply to 08h...and part c. goes on to say that on timeout the register should be cleared.

DO-260B, 2.2.3.3.2.11.d states: "The ADS-B Transmitting Subsystem shall not clear the Aircraft Identification Message (see 2.2.3.2.5). Note: The Aircraft Identification message, is not cleared since it contains data that rarely changes in flight and is not frequently updated."

We need the documents to be consistent on the clearing of the Aircraft Identification Registers (08 and 20) and they should probably be handled the same way.

Take care,
Kevin Wilson
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CNS Engineering
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From RTCA DO-181D:

2.2.23.1.4.2 Register Timeout

The transponder **shall** clear all 56-bits of the airborne position, surface position, squitter status and velocity GICB Registers 05₁₆, 06₁₆, 07₁₆ and 09₁₆ if these registers are not updated within two seconds of the previous update. This timeout **shall** be determined separately for each of these registers. The internal insertion of data by the transponder into these registers (altitude and surveillance status) **shall** not qualify as a register update for the purposes of this timeout condition.

Notes:

- 1. These registers are cleared to prevent the reporting of outdated position, velocity and squitter rate information.*
- 2. The Identification Register 08₁₆, is not cleared since it contains data that rarely changes in flight and less frequently updated. The event-driven Register, 0A₁₆ does not need to be cleared since its contents are only broadcast once each time that the register is loaded.*

Transponder data insertion and squitter transmission **shall** not be affected by a register timeout event except as specified in §2.2.23.1.3.a.

Note 3: *During a register timeout event, the ME field of the Extended Squitter may contain all zeroes, except for any data inserted by the transponder.*

2.2.24.6.2 Register 20₁₆ -- Data Requirements

2.2.24.6.2.1 Data Selection Priority

Use of Flight Identification or Aircraft Registration Data in Register 20₁₆ **shall** comply with the following guidelines:

Note: *Aircraft Registration Data may also be used in Register 08₁₆ when Extended Squitter is implemented. As such, the requirements inferred below will also apply to Register 08₁₆ when Extended Squitter is implemented.*

- a. If Flight Identification data is available at anytime during unit operation, then flight identification data **shall** be inserted into the character subfields of Register 20₁₆.

Note: *Flight Identification data is normally provided via ARINC Labels 233 through 237 or by Label 360 for block transfer data. Available data means that the status of the data is not set to No Computed Data (NCD).*

- b. If Flight Identification data is NOT available then Aircraft Registration, if available, **shall** be inserted into the character subfields of Register 20₁₆.

Note: *If the transponder has no input from the Aircraft installation that could be used to service Register 20₁₆, then the Register 20₁₆ Character subfields are set to ZERO (0) and Register 10₁₆ (Data Link Capability Report) bit 33 is set to ZERO (0).*

- c. If Flight Identification data has been entered into Register 20₁₆ and then becomes NOT available, then the character subfields of the registers **shall** be set to all ZERO's.

- d. In all of the above cases, encoding of the character subfields in Register 20₁₆ **shall** conform to the following:

- (1). All characters will be left justified prior to encoding the Character fields.
- (2). Characters will be coded consecutively without intervening SPACE codes.
- (3). Any unused character spaces at the end of the subfield should contain a SPACE character code.

Note that there is a spelling error in the original test for item "(3)" where "contain" is spelled as "conatain".

- (4). Any extra characters shall be truncated.

2.2.24.6.3 Register 20₁₆ – Flight Identification Update Rates

- a. The minimum update interval at which Register 20₁₆ **shall** be reloaded with valid data is 5.0 seconds.

Note: *Effectively, Register 20₁₆ must be updated every 5.0 seconds or sooner.*

- b. If Register 20₁₆ cannot be updated within a 10.0 second timeframe (e.g., twice the specified minimum update interval of 5.0 seconds), then:

- (1). The contents of of the character field of Register 20₁₆ **shall** be set to ZERO (0).
- (2). Bit 7 of Register 17₁₆ **shall** be set to ZERO (0).
- (3). Bit 33 of Register 10₁₆ **shall** be set to ZERO (0). (see §2.2.24.3.2.4.)

- (4). Bit 25 of Register 18₁₆ **shall not** change state if Register 20₁₆ has been properly serviced during the power-on cycle. If Register 20₁₆ has not been properly serviced during the power-on cycle, then bit 25 of Register 18₁₆ must be verified as being set to ZERO (0) (see §2.2.24.5.1 and §2.2.24.5.2.4).
- c. The time between availability of data that causes a change in Register 20₁₆ and the time that the change is made to Register 20₁₆ **shall** be less than the minimum update interval specified as 5.0 seconds.

Note: *The time between establishing availability of data and the time of updating Register 20₁₆ should be minimized (e.g., data latency should be minimized).*

From RTCA DO-260B:

2.2.3.3.2.11 ADS-B Message Timeout

- “d. The ADS-B Transmitting Subsystem shall not clear the Aircraft Identification Message (see 2.2.3.2.5).

Note: The Aircraft Identification message, is not cleared since it contains data that rarely changes in flight and is not frequently updated.”

Appendix A, Table A-1

Specifies time out for Register 08₁₆ as 15.0 seconds

Specifies time out for Register 20₁₆ as 5.0 seconds

Then the last paragraph of Section A.1.2, provides:

“The details of the data to be entered into the registers assigned for Extended Squitter will be as defined in this Appendix. Table A-1 specifies the minimum update rates at which the appropriate transponder register(s) will be reloaded with valid data. Any valid data will be reloaded into the relevant field as soon as it becomes available at the Mode S Specific Services Entity (SSE) interface regardless of the update rate. **If data are not available for a time no greater than twice the specified “maximum update interval”, or 2 seconds (whichever is the greater), then the status bit (if provided) will indicate that the data in that field are invalid, and the field will be ZEROed.**”

Section A.1.5.2.d provides:

- “d. The ADS-B Transmitting Subsystem shall not clear the Aircraft Identification Message (see 2.2.3.2.5).

Note: The Aircraft Identification message, is not cleared since it contains data that rarely changes in flight and is not frequently updated.”

From ARINC-718A: Attachment 3A-1, Notes for Attachment 3A.

12. Registers 08_{HEX} and 20_{HEX} allow for encoding only 8 characters. On certain airframe configurations this information may be provided within ARINC 429 Labels 233-237 or Label 360. In all cases, encoding of these register subfields should conform to Annex 10, Volume IV section 3.1.2.9 where:

- All characters will be left justified prior to encoding the Character fields.
- Characters will be coded consecutively without intervening SPACE codes.
- Any unused character spaces at the end of the subfield should contain a SPACE character code.
- Any extra characters will be truncated

The Sign Status Matrix (SSM) of labels 233 through 237 should be treated by the transponder as follows:

SSM 233 - 237		
BIT		MEANING
31	30	
0	0	Normal Operation
0	1	No Computed Data
1	0	Functional Test
1	1	Normal Operation

It is recommended that control panels and other devices supplying these labels do so by setting the SSM of labels 233 through 237 to 1,1 for normal operation in accordance with ARINC 429 Part 1.

COMMENTARY

The following information is provided to clarify the confusion that has existed in the industry in regards to definition of the SSM for labels 233 through 237. This document now establishes the SSM to be consistent with ARINC 429 Part 1 as given below. Implementers should take note that this reflects a change from what was previously defined in ARINC 718 and EUROCAE ED-86.

ARINC 429 Part 1 Attachment 1 identifies labels 233 through 237 as ACMS data having binary (BNR) format. Word structure for labels 233 through 237 is provided in ARINC 429 Part 1, Attachment 6. ARINC 429 Part 1, Section 2.1.5.2 defines the SSM for binary words as follows:

BNR SSM		
BIT		MEANING
31	30	
0	0	Failure Warning
0	1	No Computed Data
1	0	Functional Test
1	1	Normal Operation

Previous definitions of ARINC 429 labels 233 through 237 provided in ARINC 718 and subsequent documents identified the SSM for both BCD and discrete data. The SSM for these words include information from the following two tables:

BCD SSM (Old)			DISCRETE SSM		
BIT		MEANING	BIT		MEANING
30	31		31	30	
0	0	VALID	0	0	Normal Operation
0	1	No Computed Data	0	1	No Computed Data
1	0	Functional Test	1	0	Functional Test
1	1	Not Defined	1	1	Failure Warning

13. Flight Identification or Aircraft Registration data usage should adhere to the following guidelines:

- a. In accordance with the intent of ICAO Annex 10, Volume IV, Section 3.1.2.9, if Flight Identification data (Labels 233 – 237, respectively or Label 360) is available (i.e., proper labels received and SSM is not set to No Computed Data (NCD)) at anytime during unit operation, then flight identification data should be inserted into the character subfields of registers 08_{HEX} and 20_{HEX}.
- b. If flight identification data is not available (i.e., no labels received or SSM set to NCD) then Aircraft Registration should be inserted into the character subfields of registers 08_{HEX} and 20_{HEX}.

On certain airframe configurations Aircraft Registration data may be provided within ARINC 429 Labels 301 – 303.

- c. If flight identification data has been entered into registers 08_{HEX} and 20_{HEX} and then becomes not available, then the character subfields of the registers should all be set to “0”.

Note that Aircraft Registration data must not be used to fill the character subfields of the registers once flight identification data has been used during the transponder power-on cycle.

- d. In all of the above cases, encoding of the character subfields in registers 08_{HEX} and 20_{HEX} should conform to ICAO Annex 10, Volume IV, section 3.1.2.9 where:
- All characters will be left justified prior to encoding the Character fields.
 - Characters will be coded consecutively without intervening SPACE codes.
 - Any unused character spaces at the end of the subfield will contain a SPACE character code.
 - Any extra characters will be truncated.

From ICAO Doc. 9871:

Appendix A, Table A.2.1

Specifies time out for Register 08₁₆ as 15.0 seconds

Specifies time out for Register 20₁₆ as 5.0 seconds

Section A.2.1.1 then provides the following:

“A.2.1.1 The details of the data to be entered into the assigned registers shall be as defined in this appendix. The above table 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 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.”

Section A.2.4.2 then provides the following note:

“Note 2.— The identification register, 08₁₆, is not cleared since it contains data that rarely changes in flight and is less frequently updated. The event-driven register, 0A₁₆ or equivalent transmit register, does not need to be cleared since its contents are only broadcast once each time that the register is loaded (see §A.2.5.5).”

From RTCA DO-181D, Appendix B:

Appendix B, Table B.2.1

Specifies time out for Register 08₁₆ as 15.0 seconds

Specifies time out for Register 20₁₆ as 5.0 seconds

Section B.2.1 then provides the following:

B.2.1 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 §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. The data link capability report (Register 10₁₆) shall be updated within one second of the data changing and at least every four (4) seconds thereafter.

END OF DOCUMENT: