RTCA Special Committee 209

ATCRBS / Mode S Transponder

Meeting #5

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Proposed Changes to Selective Lockout Tests and Altitude Tests in Section 2.5

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SUMMARY

This Working Paper contains an update to the proposed changes to Procedure #5 Selective Lockout Tests that reduces the test complexity by eliminating the process of starting each lockout timer with all UF codes.

This Working Paper also proposes replacing the unnecessarily complex altitude report test procedure (Procedure #10) with a test similar to the altitude test in RTCA DO-260A.

The following changes to §2.5.4.5 Procedure #5 Selective Lockout Tests were initially discussed at Meeting #4. The following excerpt from the test procedure contains a draft of proposed changes pending approval of SC-209.

The problem with the test procedure was originally presented in SC209-WP-04-15 and it was agreed by SC-209 that the 2nd Test #2 for "All Other Transponders" was flawed. (The error lies in the use of the interim timer restarts with the UF=5 and UF=20 that are not really tested if the last timer restart with the UF=21 works properly.) The consensus during the Meeting #4 discussion was to use the first Test #2 sequence for all transponders and simply rotate through the applicable UF codes for the equipment level being tested. It was agreed that it is not necessary to test each timer with all applicable UF codes since there is no direct correlation with a timer (II or SI) and the UF code of the interrogation that starts it.

2.5.4.5 Procedure #5 Selective Lockout Tests

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Test #2 Multisite T_1 Timer and Lockout: Restart Capability and Sensitivity to All Valid Formats (~~Basic~~All Transponder~~s~~)

Time (sec)	Action
0.0	Start timer with UF=4.
0.02	Verify lockout to timer's II or SI.
4.5	Restart timer with UF=5.
21.4	Verify lockout for timer's II or SI.
23.6	Verify non-lockout for timer's II or SI.

Interlace all timers in approximately 0.3-second intervals.

For Level 2 transponders and above alternate using UF=4 and UF=20 interrogations to start the timers, and alternate using UF=5 and UF=21 interrogations to restart timers.

If the test at 21.4 seconds fails, the timer has not been restarted.

~~Test #2 Multisite T_1 Timer and Lockout: Restart Capability and Sensitivity to all Valid Formats (All Other Transponders)~~

~~Time (sec)~~	~~Action~~
~~0.0~~	~~Start timer with UF=4.~~
~~0.02~~	~~Verify lockout to timer's II or SI.~~
~~4.5~~	~~Restart timer with UF=5.~~
~~9.0~~	~~Restart timer with UF=20.~~
~~13.5~~	~~Restart timer with UF=21.~~
~~20.4~~	~~Verify lockout for timer's II or SI.~~
~~24.9~~	~~Verify lockout for timer's II or SI.~~
~~30.4~~	~~Verify lockout for timer's II or SI.~~
~~32.6~~	~~Verify non-lockout for timer's II or SI.~~

~~Interlace all timers in approximately 0.3-second intervals~~

~~If any one of the tests at 20.4, 24.9, or 30.4 seconds fail, the timer has not been restarted.~~

There was discussion at SC-209 Meeting #4 on the subject of making the Procedure #10 Altitude Report Tests test the altitude reporting logic by using a more sensible approach than the current use of hundreds of binary patterns. It was discussed that the altitude test should include a series of inputs that exercise each bit of the altitude field and that the current test that uses all combinations of 2 ONEs and the remainder ZEROs and all combinations of 2 ZEROs and the remainder ONEs is unnecessarily complex. The following proposed replacement test procedure uses the same basic test procedure as RTCA DO-260A (§2.4.3.2.3.4.1, Verification of "Barometric Altitude" in ADS-B Airborne Position Messages).

2.5.4.10 Procedure #10 Altitude Report Tests

(Subparagraph 2.2.l3.1.2 a (l) – in ATCRBS)
(Subparagraph 2.2.13.l.2 a (2) – in Mode S)
(Subparagraph 2.2. l6.2.ll – interface)

This test procedure verifies that the altitude code as it is set into the interface, appears correctly in both ATCRBS and Mode S replies.

~~Pattern Selection~~

~~Test patterns are chosen so that the most likely failure modes (incorrect wiring of the interface connector, register malfunction, etc.) can be found. The following systematic test pattern generation is recommended:~~

~~Choose all patterns consisting of two ONEs and the remainder ZEROs and all patterns consisting of two ZEROs and the remainder ONEs. These patterns, together with the all-ZEROs pattern, shall be used for verification.~~

Transponder Designs

In ATCRBS replies only 11 of the possible 13 pulses are used; X and D1 are not part of the code. Additionally, some transponders may not need the capability to transmit the D2 and/or D4 pulses which start at 62,000 and 30,750 ft respectively. At the other extreme, a transponder with the capability to report altitude in meters must have the capability to transmit ONEs in all 13 bits of the AC field. ~~If the maximum number of bits in the altitude code is n, the total number of patterns required by the above pattern selection recommendation is n(n-1)+1.~~

Transponders report altitude in ~~four~~ up to six reply formats ~~only~~depending on the implementation level: ATCRBS Mode C, DF=0, DF=4, (level 1 and above); ~~and~~ the airborne position squitter, DF=17, (extended squitter capability); and ~~if so equipped,~~ in DF=16 and DF=20 (Level 2 and above). ~~The total number of replies that should be verified for a given transponder design is the product of the number of altitude reply formats and the number of recommended test patterns for that transponder. This number ranges from a minimum of 364 replies tested for a basic transponder with 10 altitude code bits to a maximum of 918 replies tested for a data link transponder with 13 altitude code bits.~~

Test Sequence

Step 1: No Barometric Altitude Data

Disconnect the interface input for altitude code or do not supply altitude information if the interface is common with other data systems. Interrogate so that all possible altitude reporting downlink formats are generated in replies. For ATCRBS, verify that only the bracket pulses appear and that bits 20 through 32 of Mode S replies are ZEROs. Setup the transponder to transmit airborne position squitters and verify that the altitude field is all ZEROs.

Connect the code source to the interface input, generate a code consisting of all ZEROs and verify as above.

Step 2: Barometric Altitude Data Available

With the altitude code source connected to the interface input, a~~A~~pply the Barometric Altitude Input A values provided in the following table. Verify that the altitude appears correctly in all reply formats containing an altitude code, and in the Mode S replies and extended squitter the "Q" bit is set to ZERO (0).

Apply the Barometric Altitude Input B values provided in the following table. Verify that the altitude appears correctly in all reply formats containing an altitude code, and in the Mode S replies and extended squitter the "Q" bit is set to ONE (1) for cases 1 through 7. Verify that the "Q" bit is set to ZERO (0) for cases 8 through 10.

Table 2.5.4.10: Barometric Altitude Data Inputs

Case #	Altitude Input_A (100 foot increments)	Altitude Input_B (< 25 foot increments)
1	- 1,000	- 1,012
2	- 900	- 500
3	- 200	- 12.5
4	0	0
5	800	18,025
6	2,800	32,050
7	6,800	50,175
8	14,800	50,200
9	30,800	51,600
10	62,800	79,800

~~all test patterns as described above at the interface and verify that they appear correctly in all formats containing an altitude code.~~

For aircraft installations that support shared interfaces and aircraft bus interfaces that provide multiple altitude data sources and types, perform the above test patterns and verify that the correct altitude source is selected. Apply all sources of altitude data that are available to the transponder and verify the following: 1) the proper pressure altitude input is selected the data is referenced to the standard pressure setting of 1013.25 hectopascals (uncorrected pressure altitude), 2) that if 25-foot or better pressure altitude sources are available, pressure altitude is reported in 25-foot increments. Verify that if 25 foot or better pressure altitude sources are not connected or are not available, that 25-foot altitude is not reported.~~ted.~~

~~**1.1.1.1Procedure #11 – 4096 Code Tests**~~