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ATCRBS / Mode S Transponder MOPS Maintenance

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Test Section Modifications for Clarification for Regular Use of Non-Selective Lockout

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SUMMARY

This document provides proposed test section changes for the related requirement clarifications and proposed DI = 3 change described in this summary and provided in detail in working paper "SC209-WP11-16-Regular Use of Non-Selective Lockout PC=1 with DI=1&7.pdf"

It may not be clear that the transponder should interpret multisite lockout in an interrogation where DI = 1, 7 and non-selective lockout in the same interrogation where PC = 1, and set the T_D and appropriate T_L timers accordingly from that single interrogation.

This function is useful as a means of providing transponder lockout to ATCRBS/Mode S All-Call in a netted interrogator configuration using multisite lockout for network coordination. This can curtail nuisance replies to ATCRBS-Only All-Call interrogations that seem to be the result of misinterpretation of a garbled narrow P4 pulse.

The committee may also consider adding interpretation of PC = 0, 1 in an interrogation where DI = 3 to support SI lockout and non-selective lockout in a single interrogation.

2.5.4.4 Procedure #4 Non-Selective Lockout Tests

(§2.2.18.2.4)

Non-selective lockout is initiated on receipt of a correctly addressed interrogation UF=4, 5, 20, 21 containing PC=1 or LOS=1 together with IIS=0. This starts the T_D timer which holds the lockout condition for 18 ±1.0 seconds.

Non-selective Lockout applies to both (8 and 21 microseconds) ATCRBS/Mode S All-Calls and to UF=11 with IC and CL=0.

The lockout state is verified by interrogating with the locked-out All-Call types and by observing that a reply is not generated.

The lockout duration is verified by interrogation with the locked-out All-Call types 100 milliseconds before the earliest permissible timer runout and by observing that a reply is not generated.

The lockout termination is verified by interrogation with the locked-out All-Call types 100 milliseconds after the latest permissible timer runout and by observing that a reply is generated.

The timer restart feature is verified by transmitting a second lockout command while the lockout is still in effect and by observing that lockout termination occurs after the latest permissible timer runout reckoned from the last lockout command.

Negative tests verify that interrogation patterns not specifically designated as lockout commands do not cause a lockout condition in the transponder, and that lockout affects only the specified formats.

2.5.4.4.1 Positive Tests

Interrogate with UF=4, DI=3, PC=1.

Verify: Lockout state, lockout duration, lockout termination.

Repeat with UF=5, PC=1 for Level 1 transponder. Repeat with UF=5, UF=20, UF=21 and PC=1 for all other designs.

Repeat, using LOS=1 with IIS=0 as the lockout command.

Repeat with UF=4, DI≠3, PC=1.

Recommended Test Sequence:

Item	Time (sec)	Action
A	0	Interrogate with UF=4, PC=1.
B	0.02	Verify lockout with ATCRBS Mode A/Mode S.
C	0.04	Verify lockout with ATCRBS Mode C/Mode S.
D	0.06	Verify lockout with UF=11, PR=0, IC=0, CL=0.
E	16.9	Repeat items B, C, D.
F	19.1	Verify termination with All-Call.
G	19.12	Verify termination with ATCRBS Mode C/Mode S.
H	19.14	Verify termination with UF=11, PR=0, IC=0, CL=0.
I	21.0	Interrogate with UF=5, PC=1.
J	21.02	Verify as in items B, C, D.
K	26.0	Interrogate with UF=20, PC=1.
L	26.02	Verify as in items B, C, D.
M	31.0	Interrogate with UF=21, PC=1.
N	31.02	Verify as in items B, C, D.
O	41.9	Verify as in items B, C, D.
P	46.9	Verify as in items B, C, D.
Q	50.1	Verify termination as in items F, G, H.

Note: *This sequence must be modified for Level 1 transponders, because they do not accept long interrogations.*

2.5.4.4.2 Required Negative Tests

a. PC Discrimination

The interrogation patterns are:

UF = 4, 5, 20, 21.
PC = 0 and DI≠3,
PC = 0 and DI=3 and LSS=1 and SIS=0,
~~PC = 1 and DI=3,~~
PC = 2, 3, 4, 5, 6. 7.

Total number of patterns = ~~36~~ 32.

With the transponder not in non-selective lockout state, interrogate with all of the above patterns consecutively. Verify that, after the sequence, the non-selective lockout state does not exist.

b. Broadcast Discrimination

The interrogation patterns are:

UF = 4, 5, 20, 21.
PC = 0, 1, 2, 3, 4, 5, 6, 7.
IIS = 0
LOS = 1

Address = Broadcast (FF FFFF hex).
Total number of patterns = 32.

With the transponder not in non-selective lockout state, interrogate with all patterns consecutively. Verify that, after the sequence, the non-selective lockout state does not exist.

c. Address Discrimination

The interrogation patterns are:

UF = 4, 5, 20, 21.
PC = 1.

Address: not for this transponder.
Total number of patterns = 4.

With the transponder not in non-selective lockout state, interrogate with all of the above patterns. Verify that, after the sequence, the non-selective lockout state does not exist.

d. II and SI Discrimination

The interrogation patterns are:

UF = 11.
PR = 0.
CL = 0 through 1, with IC = 1 through 15
CL = 2 through 4, with IC = 0 through 15.

Total number of patterns = 78.

With the transponder in non-selective lockout state, interrogate with all of the above patterns and verify that the corresponding II or SI code is not locked out.

e. All-Call Discrimination

This test verifies that the lockout state applies only to All-Call formats and not to ATCRBS or discrete interrogations. The interrogation patterns are:

All non-All-Call formats for which the transponder is designed (Procedure #2 – §2.5.4.2).

With the transponder in non-selective lockout state, interrogate with all of the above patterns and verify that they are not locked out.

2.5.4.5 Procedure #5: Selective Lockout and Independence of Non-Selective Lockout Tests

(§2.2.18.2.5)

Selective lockout is initiated on receipt of a correctly addressed interrogation UF=4, 5, 20, or 21 containing DI=1, 7; LOS=1 and IIS from 1 to 15, or DI=3, LSS=1 and SIS from 1 to 63. This starts the T_L timer associated with the received II or SI code and holds the lockout condition for 18 ±1.0 seconds.

Selective lockout applies only to UF=11 with II or SI corresponding to the running T_L timer.

Selective and non-selective lockout are independent and not mutually exclusive and may be controlled in the same interrogation. This is done using PC=1 to initiate or restart non-selective lockout in the same interrogation used to initiate or restart selective lockout with any non zero IIS or SIS code.

The lockout state, duration, termination and restart are defined and tested as described in §2.5.4.4. Negative tests follow the same procedures and have the same purpose as described in §2.5.4.4.

Pattern Definition for Level 1 Transponders

Positive Interrogation Patterns Per Timer

UF: 2 codes.
DI: 2 codes with LOS=1 or 1 code with LSS=1. Total: 4 patterns for II timers, 2 patterns for SI timers starting lockout.

Total Interrogation Patterns Per Timer

UF: 2 codes.
DI: 2 codes with LOS=0,1; 1 code with LSS=0, 1
5 codes with SD field bits 23 & 26 = 1
Total: 20 possible patterns for II timers, 18 possible patterns for SI timers.

Positive test patterns: 2 or 4.
Negative test patterns: 16.

Pattern Definition of All Other Transponder Designs

Positive Interrogation Patterns Per Timer

UF: 4 codes.
DI: 2 codes with LOS=1 or 1 code with LSS=1.
Total: 8 patterns for II timers, or 4 patterns for SI timers starting lockout.

Total Interrogation Patterns Per Timer

UF: 4 codes.
DI: 2 codes with LOS= 0,1; 1 code with LSS=0,1;
5 codes with SD field bits 23 & 26 = 1
Total: 40 possible patterns for II timers, 36 possible patterns for SI timers.

Positive test patterns: 4 or 8.
Negative test pattern: 32.

Note: *The 8 negative test patterns per UF code are as follows: For each value of DI (0 – 7) set the IIS or SIS code correctly. For DI code values where there is no IIS or SIS subfield within the SD field, set the corresponding bits (bits 17-20 for IIS or 17-22 for SIS). If DI=1 or 7, set LOS=0, for all other values of DI, set bit 26=1. If DI=3, set LSS=0, for all other values of DI, set bit 23=1. Set PC=0.*

Test Sequence

Because 78 timers, each running 18 ±1.0 seconds, are involved, a test sequence is shown here that minimizes the time needed, while providing a comprehensive validation of transponder performance.

Principle of Test Sequence

A lockout timer is started by a surveillance or Comm-A interrogation and with the next interrogation, the lockout state is verified for UF=11 with the corresponding II or SI. Just before the earliest and just after the latest timer runout duration, lockout and non-lockout state is verified.

Timer intervals must be interlaced to verify their independence and to save time.

The requirement that each timer can be restarted while running must also be verified.

Independent non-exclusive operation of selective and non-selective lockout is verified during the selective lockout test by setting PC=1 in selected selective lockout interrogations, and verifying that the non-selective and selective lockout timers operate properly.

Test #1 Multisite, T_L Timer and Lockout: Timer Duration and Insensitivity to Non-Valid Signals (All Transponders)

Time (sec)	Action
0.0	Start timer with UF=4. Use PC=1 in every eleventh selective lockout timer interrogation of the 78 timers, i.e., the 1st, 12th, 23rd, 34th … and 78th timers.
0.02	Verify lockout to timer's II or SI with UF=11.
0.04 to 1.62	Verify non-lockout to all other non-locked out IIS and SIS (times 0.9 and 1.1 will be used for the last 2 steps of the sequence for timers started previously with interlace, see *note* below), and non-lockout of non-locked out non-selective lockout (i.e., for the 11th, 22nd, 33rd … and 77th selective lockout timers).
2.0	Start next timer for interlace.
3.64	Try timer restart with correct IIS or SIS and incorrect DI-LOS and DI-LSS combinations (DI:0 – 7 = 8 combinations) (see *note* above).
16.9	Verify lockout to timer's II or SI with UF=11. Verify non-selective lockout for every eleventh selective lockout timer of the 78 timers, i.e., the 1st, 12th, 23rd, 34th … and 78th timers.
19.1	Verify non-lockout. Verify non-selective non-lockout for every eleventh selective lockout timer of the 78 timers, i.e. the 1st, 12th, 23rd, 34th … and 78th timers.

If the last test fails, the timer either runs too long or has been restarted by a non-valid signal.

Note: *Test #1 provides the basic timing of a test sequence that satisfies the principles of the test procedure while maintaining a maximum of 50 interrogations per second. Because the test sequence calls for interlacing multisite lockout timers (in this case one is started every 2 seconds), the above sequence will need to accommodate the critical timer verifications that occur at 16.9 and 19.1 seconds relative to the start of each timer. When the test sequence reaches 16.9 and 19.1 seconds after the start of each timer it will be 0.9 and 1.1 after the start of a new timer. Priority is given to verify the lockout of the earlier timer at the correct time, while the verification of non-lockout to all other timers is scheduled around these critical measurements.*

Test #2 Multisite T_L Timer and Lockout: Restart Capability and Sensitivity to All Valid Formats (All 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.
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. During the fifth sequence of this test set PC=1 (PC=0 for all other sequences) and verify non-selective lockout and non-lockout at the same time as the II or SI timer.

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

Test #3 - Broadcast Discrimination related to IIS

Run test for each IIS, using interrogations with broadcast address FF FF FF {HEX}

Time (sec)	Action
0.00	Interrogate with UF=20, DI=1, LOS=1.
0.02	Verify non-lockout to IIS (reply to UF = 11).
0.04	Start timer with UF=21, DI=1, LOS=1.
0.06	Verify non-lockout to IIS (reply to UF = 11).

Test #4 - Broadcast Discrimination related to SIS

Run test for each SIS, using interrogations with broadcast address FF FF FF {HEX}

Time (sec)	Action
0.00	Interrogate with UF=20, DI=3, LSS=1.
0.02	Verify non-lockout to SIS (reply to UF = 11).
0.04	Interrogate with UF=21, DI=3, LSS=1.
0.06	Verify non-lockout to SIS (reply to UF = 11).

Note: *Any other tes -procedure not involving lockout may be run simultaneously with Test #1 as long as the tests do not interfer with each other.*