

Working Paper SC209-WP03-13

Wm. A. Thedford

August 9, 2006

Subject: Invalid 24-bit address

In December I was asked by EUROCAE WG49 to draft text for the transponder processing of an Address Announced (AA) equal to all ZERO's or all ONE's.

The TSG position discussed was that in that case the best solution was for the transponder to either go to power-off or standby. Review of the requirements revealed that NATO military transponders, including US military transponders, have the ability of being put in the "ATCRBS only" or "Mode S off" state which disables all Mode S-unique functionality and operates as an ATCRBS transponder. Additionally, Dieter Kunze noted that there were some general aviation transponders have both the Mode S off functionality and the ability to change the AA from the front panel of the transponder.

The working paper presented by Mikael Ponnau is provided below. There were some text adjustments which I have not captured and which should be in the WG49 minutes when they are distributed.

AI 04-12 – Illegal Mode S

Bill Thedford – December 17, 2005

Further completed by Mikaël Ponnau – July 3rd, 2006

General comments form Bill:

1. I have added definitions for Power Off Condition and Standby State. I do not consider them essential, however.
2. I added h. to 3.21 and not 3.20 because I considered that this standard (what to do when AA is all ZEROs or ONES) is new and would be imposed only on new or upgraded transponders. Hence, Level 1 transponders are not the subject¹.
3. The recent TSG meeting in Ft. Lauderdale, FL presented the subject of the processing of an invalid AA. The approach presented here should be in alignment with that discussion.
4. I put the test in 5.4 rather than 5.5. It could go either place, but this seems satisfactory to me.
5. There does not seem to be a need to test this function in flight.

Regards,
Wm. A. Thedford

The following draft text is proposed. The text highlighted in yellow was accepted during the WG-49 in Toulouse in March 2006. The new text for this meeting in Paris in July 2007 is highlighted in green and completes action A6/07. That in blue is simply a comment that no change has been made. The text highlighted in Red completes action A7/05 for Roland Mallwitz.

1.5.2 Definitions

Power Off Condition – The condition in which the transponder electrical power is not applied to the receiver, transmitter or related components.

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Standby State – The condition in which transponder electrical power may be applied to the receiver, transmitter and related components but the transponder is disabled from transmitting. In this state the transponder does not reply to interrogations and does not squitter any information in any Mode A/C/S format.

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¹ Comment from Mikaël: I have indeed inserted the text in 3.17 since it really concerns all Mode S transponders, including level 1 transponders.

3.14.3 Failure Indication

- a. An indication shall be provided of the validity/non-validity of the equipment.
- b. Any failure detected by the self-test, squitter monitor or other monitoring function shall cause the indication to assume the invalid state.
- c. Momentary power interruptions shall not cause indication of the invalid state.
- d. The status of the equipment shall be indicated to the flight crew.
- e. Failures related to the 24 bit discrete address shall generate a diagnostic error message in order to alert maintenance personnel (if a change in the 24 bit discrete address is detected or if a 24 bit discrete address consisting of all ONEs or all ZEROs is read during the power-on initialisation process).

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3.17.1 Direct Data

a. Fixed Direct Data

(1) 24 Bit Aircraft Address. During the power-on initialisation process, the transponder shall read and store its 24-bit discrete address. Thereafter, the address used by the transponder shall not change from the value stored at power-up. The transponder should continue to monitor the 24-bit discrete address after the initial read and store at power-up. If a change in the 24-bit discrete address is detected after the initial read and store, the transponder shall continue to use only the 24-bit discrete address stored at power-up and shall generate a diagnostic error message in order to alert maintenance personnel to the occurrence of intermittent discrete address bit input data. If the transponder 24-bit discrete address is set to all ONEs or all ZEROs at startup then this error condition shall be indicated to the pilot and the transponder shall either transition to Standby State or Power Off Condition.

Note 1: this last requirement is imposed to specifically disallow transponders from operating with invalid addresses. This condition has been observed in airspace operations and it poses a number of unsafe conditions.

Note 2: if there is no other transponder active (not in Standby or a Failed condition), then TCAS will declare a "TCAS System Fail" or enter the "Standby" condition." (3.23.4 ACAS-Compatible Transponder Automatic Performance Monitoring).

Note 3: If this condition occurs at startup then the transponder should be deactivated until the condition is corrected.

Note 4: Some Mode S transponders may also be able to operate in Mode A/C only (in that case it will reply to P1-P3-P4 short interrogations and will not transmit any squitter). For these transponders if the 24-bit AA is set to all ONES or ZEROs then it is permissible for the transponder to transition to Mode A/C functionality. This condition will disable the operation of ACAS II due to the loss of the Mode S functionality.

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5.4.9.3 Failure Indication (Paragraph 3.14.3)

The manufacturer shall demonstrate that failures are properly detected by the self test or monitors and cause the indication to assume the "invalid" state. The generation of diagnostic error messages related to illegal 24 bit discrete addresses is tested in section 5.4.12.1.2.

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5.4.12.1 Fixed Direct Data

(Paragraph 3.17.1 a.)

5.4.12.1.2 Test Procedure

With the transponder RF port connected to the RF port of the Transponder Test Set, (Figure 5.3) perform the following test sequences:

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e. Step 5 – Invalid AA

Put the transponder in the Power Off Condition and set the AA to all ZEROs. Turn on the transponder and verify that a transponder error condition is set.

Note : the transponder will normally either go into Standby State, revert to a Mode A/C transponder or return to the Power Off Condition.

Repeat this test with the AA set to all ONES.

Put the transponder in the Power On Condition with an AA set to ONE for the first bit and ZEROs for all other bits. Verify that the transponder functions normally as indicated in steps 1 and 2.

Without putting the transponder in Power Off Condition change the AA to all ZEROs. Verify that the transponder generates a diagnostic error message for maintenance and that it keeps operating using the initial AA read during the power-on initialisation process (first bit set to ONE and all other bits set to ZEROs).

Repeat this test with the AA set to all ONEs.

Repeat with the remaining twenty-three different transponder addresses each consisting of 23 ZEROs and a single ONE.

3.23.4 ACAS-Compatible Transponder Automatic Performance Monitoring

The transponder shall be capable of detecting malfunctions in the Mode S transponder system that would degrade ACAS functioning, and upon detection shall make this information available to ACAS. In particular, loss of complete Mode S functionality shall trigger an ACAS II system failure.