RTCA Special Committee 209

ATCRBS / Mode S Transponder MOPs Maintenance

Meeting #11

In Joint Session with EUROCAE WG-49
RTCA Headquarters, Washington, DC
8 – 10 September 2010

Register 62_{16} and 65_{16}
Transmission Rate and Timeout Review
And
Change Considerations
to
RTCA DO-181D and EUROCAE ED-73C

Robert Saffell
Rockwell Collins

This Working Paper is provided in response to **Action Item 10-10**.

This working paper is a continuation of the effort to review transmission rate and timeout requirements for various extended squitter messages. This paper concentrates on reviewing the issues with Register 62_{16} and Register 65_{16} which represent the Target State and Status and the Aircraft Operational Status messages respectively. Both of these messages were changed during updates to RTCA DO-260B. Consequently, changes will be necessary in RTCA DO-181D and ED-73C.

Introduction:

This document presents the current issues existing in RTCA DO-181D in regards to Register 62_{16} and 65_{16}. These issues arise due to the fact that these messages were changed during the development of RTCA DO-260B.

Throughout this document, original text from RTCA DO-260B and/or DO-181D is presented in paragraphs having indented blue text. Areas of concern are highlighted in yellow. General discussion for this document is presented in paragraphs having non-indented red text.

Discussion:

1.0 Review of RTCA DO-260B BDS 6,2 and 6,5 Coverage

a. Review of RTCA DO-260B provides the following requirements in regards to Transmission Rates and Termination of the Target State and Status (BDS 6,2) and the Aircraft Operational Status (BDS 6,5) Messages.

2.2.3.3.1 Transmission Rates for Transponder – Based Transmitters

2.2.3.3.1.1 Transmission Rates Compliant with RTCA DO-181D (EUROCAE ED-73C)

ADS-B transmitters based on Mode S transponders **shall** comply with the Message Transmit Rates specified in RTCA DO-181D (EUROCAE ED-73C), for each class of transponder defined in the latest version of FAA TSO C112 (ETSO 2C112).

Note: *The requirements of RTCA DO-181D (EUROCAE ED-73C) are consistent with the requirements of ICAO Annex 10, Volume IV, fourth edition, July 2007, §3.1.2.8.6.4.*

b. Note that transmit rate requirements are referred to RTCA/DO-181D.

2.2.3.3.1.2 Transmission Rates Not Specified in RTCA DO-181D (EUROCAE ED-73C)

When the transmission rate of a particular message type is not specified in RTCA DO-181D (EUROCAE ED-73C), then the Mode S Transponder-Based ADS-B transmitters **shall** deliver those messages at the rates specified in the following subparagraphs for Stand Alone Transmitters. If there is conflict between the requirements of RTCA DO-181D (EUROCAE ED-73C) and this document, then the requirements of RTCA DO-181D (EUROCAE ED-73C) **shall** be adhered to.

Note: *The possible transmission time epochs should not be correlated with UTC to preclude inadvertent synchronization of transmissions from different aircraft.*

Table 2-79 summarizes the broadcast rates of the 1090ES ADS-B Messages specified in these MOPS (RTCA DO-260B/EUROCAE ED-102A).

c. Note that transmit rates not specified for transponder based equipment are now referred to those provided for Stand Alone equipment.

Since the following subparagraphs fall under 2.2.3.3.1, such subparagraphs provide requirements for Transponder based equipment in regards to the Target State and Status and the Aircraft Operational Status messages.

2.2.3.3.1.4 ADS-B Periodic Status and Event-Driven Message Broadcast Rates

ADS-B Operational Status Messages and Target State and Status Messages are Periodic Status Messages that are broadcast in the same manner as the Airborne Position, Surface Position, Airborne Velocity and Aircraft Identification

Messages. Event-Driven Messages are broadcast at the rates specified under the provisions of the Event-Driven Protocol (see §2.2.3.3.1.4.6.1 and §A.1.6.4).

Note: *The Event-Driven Protocol limits event-driven message transmissions to 2 per second in any second. In previous versions of these MOPS, Periodic Status Messages were included under the event-driven protocol. In these MOPS, the analysis contained in Appendix R verifies that the combination of Periodic Status Messages and Event-Driven Messages does not exceed 2 messages per second averaged over 60 seconds.*

2.2.3.3.1.4.1 ADS-B Target State and Status Message Broadcast Rates

a. The Target State and Status Message(s) (TYPE=29, §2.2.3.2.7.1) **shall** be initiated only when the aircraft is airborne and when target state information is available and valid as a minimum.

b. The Target State and Status Message with a Subtype value of ONE (1) **shall**, for the nominal case, be broadcast at random intervals that are uniformly distributed over the range of 1.2 to 1.3 seconds relative to the previous Target State and Status for as long as data is available to satisfy the requirements of subparagraph "a." above.

c. The broadcast rates for Target State and Status Messages with a Subtype subfield value of other than ONE (1) are not defined by this version of these MOPS.

Notes:

1. *Future versions of these MOPS may require unique broadcast update intervals for each Target State and Status Message Subtype (i.e., unique for each value of the Subtype subfield).*

2. *Future versions of these MOPS may require that the broadcast rate for Target State and Status Messages be temporarily increased (e.g., for 24 seconds) following any change in target state or system status information.*

2.2.3.3.1.4.2 ADS-B Aircraft Operational Status Message Broadcast Rates

The rate at which the ADS-B Aircraft Operational Status Messages (TYPE=31 and Subtype=0/1, §2.2.3.2.7.2) are broadcast is given for various conditions in the following paragraphs:

a. Airborne Aircraft Operational Status Messages (TYPE=31, Subtype=0) **shall** be broadcast at the rates given in the following subparagraphs when aircraft operational status information is valid and when in the airborne state;

(1). No Change in TCAS RA Active/NAC_P/SIL/NIC_{SUPP} Data:

If there has been no change in the TCAS RA Active, NAC_P, SIL or NIC_{SUPP} information provided in the Airborne Aircraft Operational Status Message (TYPE=31, Subtype=0), then the messages **shall** be broadcast at random intervals that are uniformly distributed over the range of 2.4 to 2.6 seconds relative to the previous Airborne Aircraft Operational Status Message for as long as data is available to satisfy the requirements of subparagraph "a." above.

(2). Change in TCAS RA Active/NAC_P/SIL/NIC_{SUPP} Data with Target State and Status:

If there has been a change in the TCAS RA Active, NAC_P, SIL or NIC_{SUPP} information provided in the Airborne Aircraft Operational

Status Message (TYPE=31, Subtype=0), and Target State and Status Messages are being broadcast, then the Airborne Aircraft Operational Status Messages (TYPE=31, Subtype=0) **shall** be broadcast at random intervals that are uniformly distributed over the range of 2.4 to 2.6 seconds relative to the previous Airborne Aircraft Operational Status Message for as long as data is available to satisfy the requirements of subparagraph "a." above.

(3). Change in TCAS RA Active/NAC_P/SIL/NIC_{SUPP} Data with No Target State and Status:

If there has been a change in the TCAS RA Active, NAC_P, SIL or NIC_{SUPP} information provided in the Airborne Aircraft Operational Status Message (TYPE=31, Subtype=0), and Target State and Status Messages are NOT being broadcast, then the Airborne Aircraft Operational Status Messages (TYPE=31, Subtype=0) **shall** be broadcast at random intervals that are uniformly distributed over the range of 0.7 to 0.9 seconds relative to the previous Airborne Aircraft Operational Status Message for a period of 24 ±1 seconds.

b. Surface Aircraft Operational Status Messages (TYPE=31, Subtype=1) **shall** be broadcast at the rates given in the following subparagraphs when aircraft operational status information is valid and when in the ON-Ground state;

(1). Aircraft/Vehicle Not Moving:

If the aircraft/vehicle is on-ground and NOT moving, then Surface Aircraft Operational Status Messages (TYPE=31, Subtype=1) **shall** be broadcast at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds relative to the previous Surface Aircraft Operational Status Message for as long as data is available to satisfy the requirements of subparagraph "b." above.

(2). Aircraft/Vehicle Is Moving but No Change in NIC_{SUPP}/NAC/SIL Data:

If the Aircraft/Vehicle IS Moving and there has been no change in the NIC_{SUPP}, NAC, or SIL data provided in the Surface Aircraft Operational Status Message (TYPE=31, Subtype=1), then the messages shall be broadcast at random intervals that are uniformly distributed over the range of 2.4 to 2.6 seconds relative to the previous Surface Aircraft Operational Status Message for as long as data is available to satisfy the requirements of subparagraph "b." above.

(3). Aircraft/Vehicle Is Moving With Change in NIC_{SUPP}/NAC/SIL Data:

If the Aircraft/Vehicle IS Moving and there has been a change in the NIC_{SUPP}, NAC, or SIL data provided in the Surface Aircraft Operational Status Message (TYPE=31, Subtype=1), then the messages **shall** be broadcast at random intervals that are uniformly distributed over the range of 0.7 to 0.9 seconds relative to the previous Surface Aircraft Operational Status Message for as long as data is available to satisfy the requirements of subparagraph "b." above.

d. Appropriate test procedures are then provided in the following subsections:

2.4.3.3.1.4 Verification of the ADS-B Periodic Status and Event-Driven Message Broadcast Rates (§2.2.3.3.1.4)

No specific test procedures are required to validate §2.2.3.3.1.4.

2.4.3.3.1.4.1 Verification of the ADS-B Target State and Status Message Broadcast Rates (§2.2.3.3.1.4.1)

Purpose/Introduction:

The Target State and Status Message(s) (TYPE=29, §2.2.3.2.7.1) is initiated only when the aircraft is airborne, and when target state information is available and valid as a minimum. Broadcast rates for 1090 MHz Extended Squitter ADS-B Messages are summarized in Table 2-79.

Measurement Procedure:

Step 1: No ADS-B Message Broadcasts - On-Ground (§2.2.3.3.1.4.1.a & §2.2.3.3.1.4.1.b)

Provide the ADS-B Transmitting Subsystem with valid data necessary for the generation of ADS-B Target State and Status Messages (TYPE=29, Subtype=ONE), including valid target state information, and with the On-Ground condition, and verify that the ADS-B Transmitting Subsystem is not broadcasting any ADS-B Target State and Status Messages.

Step 2: No ADS-B Message Broadcasts – With No Valid State Information (§2.2.3.3.1.4.a & §2.2.3.3.1.4.1.b)

Change the status conditions to be invalid target state information, and with the Airborne condition, and verify that the ADS-B Transmitting Subsystem is not broadcasting any ADS-B Target State and Status Messages.

Step 3: ADS-B Message Broadcasts – With Valid Target State Information (§2.2.3.3.1.4.a & §2.2.3.3.1.4.1.b)

Change the status conditions to be valid target state information, with the Airborne condition, and verify that the ADS-B Transmitting Subsystem is broadcasting ADS-B Target State and Status Messages at a spacing uniformly distributed over the range of 1.2 to 1.3 seconds.

2.4.3.3.1.4.2 Verification of the ADS-B Aircraft Operational Status Message Broadcast Rates (§2.2.3.3.1.4.2)

Purpose/Introduction:

The rates at which the Aircraft Operational Status Messages (TYPE=31 and Subtype=0/1, §2.2.3.2.7.2) are broadcast is specified in §2.2.3.3.1.4.2. Broadcast rates for 1090 MHz Extended Squitter ADS-B Messages are summarized in Table 2-79.

Measurement Procedure:

Step 1: Airborne ADS-B Message Broadcasts – Target State and Status / Operational Status Messages – No Change in TCAS RA Active/NAC_P/SIL/NIC_{SUPP} Data (§2.2.3.3.1.4.2.a.(1))

Provide the ADS-B Transmitting Subsystem with valid data necessary for the generation of both Aircraft Operational Status Messages (TYPE=31, Subtype=ZERO), and ADS-B Target State and Status Messages (TYPE=29, Subtype=ONE). Ensure that the Aircraft/Vehicle is in the Airborne state. Ensure that there have been no changes in the TCAS RA Active, NAC_P, SIL or NIC_{SUPP} data used in the Airborne Aircraft Operational Status Message.

Verify that the ADS-B Transmitting Subsystem is broadcasting ADS-B Target State and Status Messages at a spacing uniformly distributed over the range of 1.2 to 1.3 seconds, and Aircraft Operational Status Messages at a spacing uniformly distributed over the range of 2.4 to 2.6 seconds.

Step 2: Airborne ADS-B Message Broadcasts – ADS-B Target State and Status / Operational Status Messages – Changes in TCAS RA Active/NAC_P/SIL/NIC_{SUPP} Data (§2.2.3.3.1.4.2.a.(2))

Provide the ADS-B Transmitting Subsystem with valid data necessary for the generation of both Airborne Aircraft Operational Status Messages (TYPE=31, Subtype=0) and Target State and Status Messages (TYPE=29, Subtype=1). Ensure that the Aircraft/Vehicle is in the Airborne state. Induce appropriate changes in the TCAS RA Active, NAC_P, SIL or NIC_{SUPP} data used in the Airborne Aircraft Operational Status Message.

Verify that the ADS-B Transmitting Subsystem is broadcasting ADS-B Target State and Status Messages at a spacing uniformly distributed over the range of 1.2 to 1.3 seconds, and Airborne Aircraft Operational Status Messages at a spacing uniformly distributed over the range of 2.4 to 2.6 seconds.

Step 3: Airborne ADS-B Message Broadcasts – No ADS-B Target State and Status / Operational Status Messages – With Changes in TCAS RA Active/NAC_P/SIL/NIC_{SUPP} Data (§2.2.3.3.1.4.2.a.(3))

Provide the ADS-B Transmitting Subsystem with valid data necessary for the generation of Airborne Aircraft Operational Status Messages (TYPE=31, Subtype=0). Ensure that the Aircraft/Vehicle is in the Airborne state and that Target State and Status Messages are not being broadcast. Induce appropriate changes in the TCAS RA Active, NAC_P, SIL or NIC_{SUPP} data used in the Airborne Aircraft Operational Status Message.

Verify that the ADS-B Transmitting Subsystem is broadcasting ADS-B Airborne Aircraft Operational Status Messages at a spacing uniformly distributed over the range of 0.7 to 0.9 seconds for a period of 24 ±1 seconds.

Step 4: Surface ADS-B Message Broadcasts – Not Moving (§2.2.3.3.1.4.2.b.(1))

Provide the ADS-B Transmitting Subsystem with valid data necessary for the generation of Surface Aircraft Operational Status Messages (TYPE=31, Subtype=1). Ensure that the Aircraft/Vehicle is in the ON-Ground state and that the Aircraft/Vehicle is NOT moving.

Verify that the ADS-B Transmitting Subsystem is broadcasting ADS-B Surface Aircraft Operational Status Messages at a spacing uniformly distributed over the range of 4.8 to 5.2 seconds.

Step 5: Surface ADS-B Message Broadcasts – No Change in NIC_{SUPP}/NAC_P/SIL Data (§2.2.3.3.1.4.2.b.(2))

Provide the ADS-B Transmitting Subsystem with valid data necessary for the generation of Surface Aircraft Operational Status Messages (TYPE=31, Subtype=1). Ensure that the Aircraft/Vehicle is in the ON-Ground state and that the Aircraft/Vehicle is moving. Ensure that there have been no changes in the NIC_{SUPP}, NAC_P, or SIL data provided in the Surface Aircraft Operational Status Message (TYPE=31, Subtype=1).

Verify that the ADS-B Transmitting Subsystem is broadcasting ADS-B Surface Aircraft Operational Status Messages at a spacing uniformly distributed over the range of 2.4 to 2.6 seconds.

Step 6: Surface ADS-B Message Broadcasts – Moving / With Change in NIC_{SUPP}/NAC_P/SIL Data (§2.2.3.3.1.4.2.b.(3))

Provide the ADS-B Transmitting Subsystem with valid data necessary for the generation of Surface Aircraft Operational Status Messages (TYPE=31, Subtype=1). Ensure that the Aircraft/Vehicle is in the ON-Ground state and that the Aircraft/Vehicle is moving. Induce appropriate changes in the NIC_{SUPP}, NAC_P, or SIL data used in the Surface Aircraft Operational Status Message (TYPE=31, Subtype=1).

Verify that the ADS-B Transmitting Subsystem is broadcasting ADS-B Surface Aircraft Operational Status Messages at a spacing uniformly distributed over the range of 0.7 to 0.9 seconds.

e. No message timeout requirements are provided in RTCA DO-260B for transponder based equipment implementing the Target State and Status and the Aircraft Operational Status messages. However, message timeout requirements are provided for Stand Alone Transmitters. Therefore, in accordance with section 2.2.3.3.1.2 (shown above) the requirements fall into the Non-Transponder based equipment requirements which start in section 2.2.3.3.2.

2.2.3.3.2 Transmission Rates for Stand Alone Transmitters

2.2.3.3.2.11 ADS-B Message Timeout

Notes:

1. *These messages are cleared to prevent the reporting of outdated position and velocity information.*
2. *During a register timeout event, the "ME" field of the ADS-B Broadcast Message may contain ALL ZEROs, except for those fields that may be updated due to the receipt of new data.*

a. The ADS-B Transmitting Subsystem **shall** clear all but the altitude and surveillance status subfields of the Airborne Position Message, if no new position data is received within two (2) seconds of the previous input data update.

Note: *During a timeout event the Format TYPE Code is set to ZERO (see §2.2.3.2.3.1.3.1).*

b. The ADS-B Transmitting Subsystem **shall** clear all 56-bits of the Surface Position Message if no new position data is received within two (2) seconds of the previous input data update.

Notes:

1. *During a timeout event the Format TYPE Code is set to ZERO (see §2.2.3.2.4.1.3.1).*
2. *When position is available, the ADS-B Transmitting Subsystem manages the movement and the ground track subfields such that the subfields and applicable status bits are set to ZERO (0) if no new data is received for the subfield within 2.6 seconds of the last data update of the subfield.*

3. *When position data is not received, all bits of the Surface Position Message are set to ZERO to avoid confusion with altitude data in the Airborne Position Message sent with TYPE Code ZERO (0).*

c. The ADS-B Transmitting Subsystem **shall** clear all 56-bits of the Airborne Velocity Message if no data is received within 2.6 seconds of the previous input data update.

Note: *The Intent Change information is not sufficient to consider that new data has been received (§2.2.3.2.6.1.3).*

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.*

e. The ADS-B Transmitting Subsystem **shall** clear each of the Selected Altitude, Selected Heading, or Barometric Pressure Setting subfields of the Target State and Status Message (see §2.2.3.2.7.1) if no new data is received within 2.0 seconds of the previous input data update for the respective subfield. Each of the subfields **shall** be cleared independently of the other subfields. That is, each of the three specified subfields **shall** be processed mutually exclusively of the other two specified subfields. The remaining subfields of the Target State and Status Message **shall not** be cleared, as they contain other integrity, mode, or status information.

f. Note the 2 second requirement to clear Selected Altitude, Selected Heading or Barometric Pressure subfields.

f. The ADS-B Transmitting Subsystem **shall not** clear the Operational Status Messages (see §2.2.3.2.7.2) since the subfields of the Message contain various integrity, mode, or status information..

g. Note that there is no requirement to clear the Aircraft Operational Status Message subfields.

g. The ADS-B Transmitting Subsystem **shall not** clear the Event-Driven Messages (see §2.2.3.2.7.8).

Note: *The Event-Driven Messages do not need to be cleared since contents of such messages are only broadcast once each time that new data is received.*

2.2.3.3.2.12 ADS-B Message Termination

a. The ADS-B Transmitting Subsystem **shall** terminate broadcast transmissions of the Airborne Position Message when position (latitude/longitude) and altitude data are not available for a period of 60 seconds.

Note: *For the Airborne Position Message, altitude data alone is sufficient to maintain broadcast of the Message once the Message has been initiated. When only altitude data is available, the Airborne Position Message continues to be transmitted even after 60 seconds. However, if the altitude data is not available for 60 seconds, then the Airborne Position Message transmission is terminated and the conditions for start-up defined in §2.2.3.3.2.1.2 are necessary to resume the transmission of Airborne Position Message.*

b. The ADS-B Transmitting Subsystem **shall** terminate the transmission of Surface Position Messages if position data that is necessary to update the Message is not available for a period of 60 seconds. Transmission termination of Surface Position Messages does not apply to Non-

Transponder Devices on aircraft that are on the surface, or on surface vehicles.

Note: *For the Surface Position Message, the receipt of new Movement, or Ground Track data is not sufficient to maintain broadcast of the message once the message has been initiated.*

c. The ADS-B Transmitting Subsystem **shall not** terminate broadcast transmissions of Aircraft Identification and Category Message even if input data necessary to update the Message is not available.

d. The ADS-B Transmitting Subsystem **shall** terminate broadcast transmissions of the Airborne Velocity Message if input data necessary to update the subfields of the Airborne Velocity Message, other than the Intent Change Flag, is not available for a period of 2.6 seconds.

Notes:

1. *The receipt of new data necessary to update any single subfield, other than the Intent Change Flag, is sufficient to maintain broadcast of the Airborne Velocity Message.*
2. *Previous versions of these MOPS required the Airborne Velocity Message to be transmitted for an additional 60 seconds with ALL ZEROs including the TYPE Code field. In the event of a loss of GPS data the Airborne Position Message would have barometric altitude in it, the Airborne Velocity Message would not. However, a receiver could not determine the difference between these cases, therefore the transmitted altitude was not usable.*

e. The ADS-B Transmitting Subsystem **shall** continue to broadcast the Target State and Status Message for as long as Airborne Position Messages are being broadcast.

Note: *Target State and Status Messages do not need to be terminated until the Airborne and Surface Position Messages are terminated since the Target State and Status Messages contain various integrity, mode, or status information that is applicable to the Airborne Position Messages.*

h. Note that termination of the Target State and Status message is at the same time as termination of the Airborne Position Message.

f. The ADS-B Transmitting Subsystem **shall** continue to broadcast the Operational Status Messages for as long as Airborne Position Messages or Surface Position Messages are being broadcast.

Note: *Operational Status Messages do not need to be terminated until the Airborne Position Messages and the Surface Position Messages are terminated since the Operational Status Messages contain various integrity, mode, or status information that is applicable to the Airborne Position Messages or the Surface Position Messages.*

i. Note that termination of the Aircraft Operational Status message is at the same time that Position messages are terminated.

g. Class B2 Non-Transponder-Based Transmitting Subsystems on Ground Vehicles **shall** provide an interface capable of putting the unit into a standby condition in which the unit suspends all message transmissions.

Notes:

1. *This interface is intended to be used by a mapping function that will automatically trigger the interface if the Transmitting Subsystem is outside a user adaptable two-dimensional geographic area.*
2. *If required because of spectrum considerations, the two-dimensional geographic area will be defined as the movement area (i.e., runways and taxiways) plus a reasonable buffer area (i.e., 50 foot buffer). Implementations of this feature should be designed such that a particular ground authority can specify a region that conserves spectrum without introducing risk of accidental termination within the movement area. Consideration should be given to precision and accuracy of the geographic region definition.*
3. *As a vendor option, this mapping function may be implemented integral to the Class B2 equipment. In this case, the interface is internal to the unit.*

j. Appropriate test procedures to validate TSS and AOC Status message timeout and termination is then provided in section 2.4.3.3.2.11 (refers to 2.4.3.3.2.2 through 2.4.3.3.2.8.2) and 2.4.3.3.2.12 (refers to 2.4.3.3.2.2 through 2.4.3.3.2.8.2).

2.0 Review of RTCA DO-181D BDS 6,2 and 6,5 Coverage

a. Review of RTCA DO-181D provides the following requirements in regards to extended squitter transmission rates and timeout.

2.2.23.1 ADS-B Extended Squitter

Mode S transponders may provide the capability to transmit Extended Squitters to support the broadcast of aircraft-derived position, identification and state information.

Note: *The broadcast of this type of information is a form of Automatic Dependent Surveillance (ADS) known as ADS-Broadcast or ADS-B.*

2.2.23.1.1 Extended Squitter Format

The format used for the Extended Squitter **shall** be the 112-bit downlink format DF=17 using II=0 and SI=0 in generating the PI field (§2.2.14.4.29).

2.2.23.1.2 Extended Squitter Types

a. Airborne Position Squitter. The airborne position Extended Squitter **shall** use format DF=17 with the contents of ground-initiated Comm-B Register 05_{16} inserted in the ME field.

Note: *A GICB request (see §2.2.19.1.12.3) containing RR equals 16, DI equals 7 and RRS equals 5 will cause the resulting reply to contain the airborne position report in its MB field.*

b. Surface Position Squitter. The surface position Extended Squitter **shall** use format DF=17 with the contents of ground-initiated Comm-B Register 06_{16} inserted in the ME field.

Note: *A GICB request (see §2.2.19.1.12.3) containing RR equals 16, DI equals 7 and RRS equals 6 will cause the resulting reply to contain the surface position report in its MB field.*

c. Aircraft Identification Squitter. The aircraft identification Extended Squitter **shall** use format DF=17 with the contents of ground-initiated Comm-B Register 08_{16} inserted in the ME field.

Note: *A GICB request (see §2.2.19.1.12.3) containing RR equals 16, DI equals 7 and RRS equals 8 will cause the resulting reply to contain the aircraft identification report in its MB field.*

d. Airborne Velocity Squitter. The airborne velocity Extended Squitter **shall** use format DF=17 with the contents of GICB Register 09_{16} inserted in the ME field.

Note: *A GICB request (see §2.2.19.1.12.3) containing RR equals 16, DI equals 7 and RRS equals 9 will cause the resulting reply to contain the airborne velocity report in its MB field.*

e. Event-driven Squitter. The event-driven Extended Squitter **shall** use format DF=17 with the contents of GICB Register $0A_{16}$ inserted in the ME field.

Note: *A GICB request (see §2.2.19.1.12.3) containing RR equals 16, DI equals 7 and RRS equals 0A will cause the resulting reply to contain the event-driven report in its MB field.*

2.2.23.1.3 Extended Squitter Rate

a. Initialization. At power up initialization, the transponder **shall** commence operation in a mode in which it broadcasts only acquisition squitters (see §2.2.18.2.6). The transponder **shall** initiate the broadcast of Extended Squitters for airborne position, surface position, airborne velocity and aircraft identification when data are inserted into GICB Registers 05_{16}, 06_{16}, 09_{16} and 08_{16} respectively. This determination **shall** be made individually for each squitter type. The insertion of altitude data into Register 05_{16} by the transponder (see §2.2.23.1.8) **shall** not satisfy the minimum requirement for broadcast of the airborne position squitter.

Note 1: *This suppresses the transmission of Extended Squitters from aircraft that are unable to report position, velocity or identity information.*

If input to the register for a squitter type stops for 60 seconds, broadcast of that Extended Squitter type will be discontinued until data insertion is resumed. The insertion of altitude by the transponder **shall** satisfy the minimum requirement for continuing to broadcast the airborne position squitter. After timeout (see §2.2.23.1.4.2), this squitter type may contain an ME field of ALL ZEROs.

Note 2: *Continued transmission for 60 seconds is required so that receiving aircraft will know that the data source for the message has been lost.*

When Extended Squitters are broadcast, transmission rates shall be as indicated in the following paragraphs. Acquisition squitters shall be reported in addition to Extended Squitters as specified in §2.2.18.2.6.c. Acquisition squitters **shall** always be reported if no Extended Squitters are reported.

b. Airborne Position Squitter Rate. Airborne position squitter transmissions **shall** be emitted as specified in §2.2.23.1.5 at random intervals that are uniformly distributed over the range from 0.4 to 0.6 seconds using a time quantization no greater than 15 milliseconds relative to the previous airborne position squitter, with the exceptions as specified in subparagraph "g."

c. Surface Position Squitter Rate. Surface position squitter transmissions **shall** be emitted as specified in §2.2.23.1.5 using one of two rates depending upon whether the high or low squitter rate has been selected (see §2.2.23.1.6). When the high squitter rate has been selected, surface position squitters **shall** be emitted at random intervals that are uniformly distributed over the range from 0.4 to 0.6 seconds using a time quantization no greater than 15 milliseconds relative to the previous surface position squitter (termed the high rate). When the low squitter rate has been selected, surface position squitters **shall** be emitted at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds using a time quantization no greater than 15 milliseconds relative to the previous surface position squitter (termed the low rate) Exceptions to this transmission rate are specified in subparagraph "g."

Notes:

1. High and low squitter rate status is determined on board the aircraft.

2. The low rate is used when the aircraft is stationary and the high rate is used when the aircraft is moving.

d. Aircraft Identification Squitter Rate. Aircraft identification squitter transmissions **shall** be emitted at random intervals that are uniformly distributed over the range of 4.8 to 5.2 seconds using a time quantization no greater than 15 milliseconds relative to the previous identification squitter when the aircraft is reporting the airborne position squitter, or when the aircraft is reporting the surface position squitter and the high surface squitter rate has been selected. When the surface position squitter is being reported at the low surface rate, the aircraft identification squitter **shall** be emitted at random intervals that are uniformly distributed over the range of 9.8 to 10.2 seconds using a time quantization no greater than 15 milliseconds relative to the previous identification squitter. Exceptions to these transmission rates are specified in subparagraph "g."

e. Airborne Velocity Squitter Rate. Airborne velocity squitter transmissions **shall** be emitted as specified in §2.2.23.1.5 at random intervals that are uniformly distributed over the range from 0.4 to 0.6 seconds using a time quantization no greater than 15 milliseconds relative to the previous velocity squitter, with the exceptions as specified in subparagraph "g."

f. Event-Driven Squitter Rate. The event-driven squitter **shall** be transmitted once, each time that GICB Register $0A_{16}$ is loaded, while observing the delay conditions specified in subparagraph "g." The maximum transmission rate for the event-driven squitter **shall** be limited by the transponder to twice per second. If a message is inserted in the event-driven register and cannot be transmitted because of rate limiting, it **shall** be held and transmitted when the rate limiting condition has cleared If a new message is received before transmission is permitted, it **shall** overwrite the earlier message.

Note: *The squitter transmission rate and the duration of squitter transmissions is application dependent. Choices made should be the minimum rate and duration consistent with the needs of the application.*

g. Delayed Transmission. Extended squitter transmission **shall** be delayed in the following circumstances:

(1) the scheduled Extended Squitter **shall** be delayed if the transponder is in a transaction cycle (see §2.2.18.2.2.k); or

(2) the scheduled Extended Squitter **shall** be delayed if an acquisition or another type of Extended Squitter is in process; or

(3) the scheduled Extended Squitter **shall** be delayed if a mutual suppression interface is active.

Note: *A mutual suppression system may be used to connect on-board equipment operating in the same frequency band in order to prevent mutual interference. Squitter action resumes as soon as practical after a mutual suppression interval.*

The delayed squitter **shall** be transmitted as soon as the condition causing the delay no longer exists.

2.2.23.1.4 Transponder Support for Extended Squitter Registers

2.2.23.1.4.1 Data Insertion

When the transponder determines that it is time to emit an airborne position squitter, it **shall** insert the current value of the barometric altitude (unless inhibited by the ATS subfield, §2.2.23.1.9) and surveillance status into the appropriate fields of Register 05_{16}. The contents of this Register **shall** then be inserted into the ME field of DF=17 and transmitted.

Note: *Insertion in this manner ensures that (1) the squitter contains the latest altitude and surveillance status, and (2) ground readout of Register 05_{16} will yield exactly the same information as contained in the previous squitter.*

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 05_{16}, 06_{16}, 07_{16} and 09_{16} 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 08_{16}, is not cleared since it contains data that rarely changes in flight and less frequently updated. The event-driven Register, $0A_{16}$ 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.*

b. NOTE that there are NO Requirements in DO-181D for Target State and Status and Aircraft Operational Status Messages. There are requirements for Event Driven which previously included these two messages.

c. Appendix B, Table B-2-1 indicates an update interval for BDS 6,2 as N/A.

For BDS 6,5, the table indicates an update interval of 2.5 seconds.

Both of these requirements are currently in conflict with DO-260B.

Consequently, Table B-2-1 needs to be updated accordingly.

Likewise, the equivalent table in ICAO Doc. 9871 will need to be updated accordingly.

d. Test Procedures provided in section 2.5.4.6.2.1 were developed when the Target State and Status and Aircraft Operational Status messages were included in the Event Driven protocol. As such, the procedures are no longer applicable and need to be extensively revised.

Conclusion/Recommendations:

The following subparagraphs present recommended changes into RTCA DO-181D needed to correct issues with Register 62_{16} and 65_{16}. These changes recommendations are based on the approach of referring the Target State and Aircraft Operational requirements to RTCA DO-260B since the messages are better defined and validated there. The alternative would be to duplicate requirements and procedures from DO-260B into DO-181D.

a. Change RTCA DO-18D section 2.2.23.1.2 subparagraph "e" and subsequent to read as follows:

2.2.23.1.2 Extended Squitter Types

e. Target State and Status. The airborne Target State and Status Extended Squitter **shall** use format DF=17 with the contents of GICB Register 62_{16} inserted in the ME field.

Note: *A GICB request (see §2.2.19.1.12.3) containing RR equals 22 (e.g., BDS1 = 6), DI equals 7 and RRS equals 2 (e.g., BDS2=2) will cause the resulting reply to contain the airborne Target State and Status report in its MB field.*

f. Aircraft Operational Status. The airborne or surface Aircraft Operational Status Extended Squitter **shall** use format DF=17 with the contents of GICB Register 65_{16} inserted in the ME field.

Note: *A GICB request (see §2.2.19.1.12.3) containing RR equals 22 (e.g., BDS1 = 6), DI equals 7 and RRS equals 5 (e.g., BDS2=5) will cause the resulting reply to contain the Aircraft Operational Status report in its MB field.*

g. Event-driven Squitter. The event-driven Extended Squitter **shall** use format DF=17 with the contents of GICB Register $0A_{16}$ inserted in the ME field.

Note: *A GICB request (see §2.2.19.1.12.3) containing RR equals 16, DI equals 7 and RRS equals 0A will cause the resulting reply to contain the event-driven report in its MB field.*

b. Change RTCA DO-18D section 2.2.23.1.3 subparagraph "f" and subsequent to read as follows:

2.2.23.1.3 Extended Squitter Rate

f. Airborne Target State and Status. Airborne Target State and Status squitter transmissions **shall** be emitted as specified in RTCA DO-260B §2.2.3.3.1.4.1.

Verification of the Airborne Target State and Status message transmission shall be performed in accordance with RTCA DO-260B §2.4.3.3.1.4.1.

g. Aircraft Operational Status. Aircraft Operational Status squitter transmissions **shall** be emitted as specified in RTCA DO-260B §2.2.3.3.1.4.2.

Verification of the Aircraft Operational Status message transmission shall be performed in accordance with RTCA DO-260B §2.4.3.3.1.4.2.

h. Event-Driven Squitter Rate. The event-driven squitter **shall** be transmitted once, each time that GICB Register $0A_{16}$ is loaded, while observing the delay conditions specified in subparagraph "g." The maximum transmission rate for the event-driven squitter **shall** be limited by the transponder to twice per second. If a message is inserted in the event-driven register and cannot be transmitted because of rate limiting, it **shall** be held and transmitted when the rate limiting condition has cleared If a new message is received before transmission is permitted, it **shall** overwrite the earlier message.

Note: *The squitter transmission rate and the duration of squitter transmissions is application dependent. Choices made should be the minimum rate and duration consistent with the needs of the application.*

g. Delayed Transmission. Extended squitter transmission **shall** be delayed in the following circumstances:

(1) the scheduled Extended Squitter **shall** be delayed if the transponder is in a transaction cycle (see §2.2.18.2.2.k); or

(2) the scheduled Extended Squitter **shall** be delayed if an acquisition or another type of Extended Squitter is in process; or

(3) the scheduled Extended Squitter **shall** be delayed if a mutual suppression interface is active.

Note: *A mutual suppression system may be used to connect on-board equipment operating in the same frequency band in order to prevent mutual interference. Squitter action resumes as soon as practical after a mutual suppression interval.*

The delayed squitter **shall** be transmitted as soon as the condition causing the delay no longer exists.

c. Change RTCA DO-18D section 2.2.23.1.4.2 to read as follows:

2.2.23.1.4.2 Register Timeout and Termination

a. The transponder **shall** clear all 56-bits of the airborne position, surface position, squitter status and velocity GICB Registers 05_{16}, 06_{16}, 07_{16} and 09_{16} 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 08_{16}, is not cleared since it contains data that rarely changes in flight and less frequently updated. The event-driven Register, $0A_{16}$ 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.*

b. Target State and Status (Register 62_{16}):

(1). Timeout of the Target State and Status message **shal**l be performed in accordance with RTCA DO-260B §2.2.3.3.2.11.e.

Verification of the Target State and Status message timeout **shall** be performed in accordance with RTCA DO-260B §2.4.3.3.2.11.

(2) Termination of the Target State and Status message **shall** be performed in accordance with RTCA DO-260B §2.4.3.3.2.12.e.

Verification of the Target State and Status message termination **shall** be performed in accordance with RTCA DO-260B §2.4.3.3.2.12.

c. Aircraft Operational Status (Register 65_{16}):

(1). Timeout of the Aircraft Operational Status message **shal**l be performed in accordance with RTCA DO-260B §2.2.3.3.2.11.f.

Verification of the Aircraft Operational Status message timeout **shall** be performed in accordance with RTCA DO-260B §2.4.3.3.2.11.

(2) Termination of the Aircraft Operational Status message shall be performed in accordance with RTCA DO-260B §2.4.3.3.2.12.f.

Verification of the Aircraft Operational Status message termination **shall** be performed in accordance with RTCA DO-260B §2.4.3.3.2.12.

d. Change RTCA DO-18D Table B-2-1 as follows:

(1). For Register 62_{16}, change the update interval to 2.0 seconds in order to be consistent with RTCA DO-260B section 2.2.3.3.2.11.e which was discussed earlier in this document.

(2). For Register 65_{16}, change the update interval to N/A in order to be consistent with RTCA DO-260B section 2.2.3.3.2.11.f which was discussed earlier in this document.

e. Change RTCA DO-18D section 2.5.4.6.2.2 as follows:

Step 8 currently reads as follows:

Step 8 Provide data to the transponder to trigger data to be loaded into GICB Register $0A_{16}$. Verify that an Event-Driven Extended Squitter is generated with the proper data content. Repeat for all supported Event-Driven Extended Squitter Message types. Event-Driven Extended Squitter Messages include BDS 6,1, BDS 6,2 and BDS 6,5: the Aircraft Status, the Target State and Status, and the Aircraft Operational Status Messages, respectively. Verify that the data contained in the GICB Register corresponding to the Event-Driven Extended Squitter Message type matches the data contained in the transmitted Extended Squitter. Update GICB Register $0A_{16}$ at a rate less than twice every second. Verify that an Event-Driven Extended Squitter is generated subsequent to each update with the proper data content. Vary the data content provided externally to the transponder and verify that the data content subsequent to update of the Event-Driven report is correct. Increase the update rate to exceed twice per second. Verify that the Event-Driven Extended Squitter rate does not exceed

twice per second, and that the data content reflects the most recent update contents.

For the following steps, for those transponders that support automatic detection of on-the-ground status, change the transponder to on-the-ground status. Configure the transponder to not inhibit Acquisition squitters when Extended Squitters are broadcast.

Change Step 8 to reads as follows:

Step 8 Provide data to the transponder to trigger data to be loaded into GICB Register $0A_{16}$. Verify that an Event-Driven Extended Squitter is generated with the proper data content. Repeat for all supported Event-Driven Extended Squitter Message types. Verify that the data contained in the GICB Register corresponding to the Event-Driven Extended Squitter Message type matches the data contained in the transmitted Extended Squitter. Update GICB Register $0A_{16}$ at a rate less than twice every second. Verify that an Event-Driven Extended Squitter is generated subsequent to each update with the proper data content. Vary the data content provided externally to the transponder and verify that the data content subsequent to update of the Event-Driven report is correct. Increase the update rate to exceed twice per second. Verify that the Event-Driven Extended Squitter rate does not exceed twice per second, and that the data content reflects the most recent update contents.

For the following steps, for those transponders that support automatic detection of on-the-ground status, change the transponder to on-the-ground status. Configure the transponder to not inhibit Acquisition squitters when Extended Squitters are broadcast.

The Working Group membership is invited to review the discussion provided herein and to provide comment as deemed necessary.

END of Document