RTCA, Inc.
1828 L Street, NW, Suite 805
Washington, DC 20036-5133, USA

Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment

Change 1

DRAFT Version 4

Draft

RTCA DO-181D, Change 1
MM DD, 20xx
Modifies RTCA/DO-181D

Prepared by: SC-209
© 20xx, RTCA, Inc.

Copies of this document may be obtained from

RTCA, Inc,
1828 L Street, NW, Suite 805
Washington, DC 20036-5133, USA

Telephone: 202-833-9339
Facsimile: 202-833-9434
Internet: www.rtca.org

Please call RTCA for price and ordering information.

Draft

Foreword

This document was prepared by Special Committee 209 (SC-209) and approved by the RTCA Program Management Committee (PMC) on MM DD, 20xx.

RTCA, Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a Federal Advisory Committee and develops consensus based recommendations on contemporary aviation issues. RTCA's objectives include but are not limited to:

- Coalescing aviation system user and provider technical requirements in a manner that helps government and industry meet their mutual objectives and responsibilities;
- Analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;
- Developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and
- Assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunications Union and other appropriate international organizations can be based.

The organization's recommendations are often used as the basis for government and private sector decisions as well as the foundation for many Federal Aviation Administration Technical Standard Orders.

Since RTCA is not an official agency of the United States Government, its recommendations may not be regarded as statements of official government policy unless so enunciated by the U.S. government organization or agency having statutory jurisdiction over any matters to which the recommendations relate.

Draft

This page intentionally left blank.

Draft

Executive Summary

The update to the *Minimum Operational Performance Standards (MOPS) for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment*, published by RTCA on October 2, 2008 as RTCA/DO-181D, is contained herein as **Change 1 to RTCA/DO-181D**, and has been produced to reflect changes that have resulted in requirements for airborne transponder equipment.

This **Change 1 to RTCA/DO-181D** xxxxxxxxxxxxxxxxxxxx.

Draft

With the publication of this document as "**Change 1 to DO-181D**" several changes are being made to RTCA/DO-181D, that are identified as necessary since the time of the publication of DO-181D. These changes include, but are not limited to:

1. Clarification;
2. Additional;
3. Changes; and
4. Other changes related to correcting additional typographical and paragraph reference errors.

Since the publication of RTCA/DO-181D in October 2008, ICAO has also been in the process of updating the ICAO SARPs to include those requirements identified in DO-181D.

Draft

Change 1 to RTCA/DO-181D

Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment

This Change document prescribes the Minimum Performance Standards (MPS) for airborne transponder equipment, modified as described in this document. The applicable standards basis for those changes requested in this document is RTCA/DO-181D, "*Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment,"* issued October 2, 2008.

Change 1 to DO-181D will use change numbers such as (1.1) through (1.xxx), in this document to describe specific changes made to RTCA DO-181D.

In the following requested changes, for those items where existing text is requested to change, the new text is underlined and highlighted in blue, and deleted text is presented in ~~strikethrough and red text~~. In those changes where a totally new section or text is inserted, all the text is presented in underline and highlighted in blue.

(**1.1**) In RTCA/DO-181D, in section §1.4.6, in the text of "Example 2," in the third line:

Replace "*125 wats*" **with** "*125 watts*"

(**1.2**) In RTCA DO-181D, in section §2.1.7, in order to strengthen the Flight ID requirements such that the display and crew entry must be simple to access and modify while on the ground or during flight, make the following changes to subparagraph "f:"

f. If the aircraft uses a flight number for aircraft identification, a means **shall** be provided for the variable aircraft identification to be inserted by the pilot while on the ground, or during flight. The means for modifying and displaying aircraft identification **shall** be a simple crew action independent of the entry of other flight data.

(**1.3**) In RTCA DO-181D, in section §2.1.11.4.4, in order to correct a value in the spacing section for the P5 pulse to sync phase reversal, make the following change:

P5 to sync phase reversal 0.40 +/- ~~0.1~~ 0.05

(**1.4**) In RTCA DO-181D, in section §2.2.3.4.1, in order to clarify the requirement for reply rate, insert a second note at the end of the paragraph as follows:

Notes:

1. *A 15 pulse reply includes 2 framing pulses, the 12 information pulses, and the SPI pulse.*
2. *The reply rate requirement of 500 replies per second establishes the minimum continuous reply rate capability of the transponder. As per the altitude and speed criteria above, the 100 or 120 replies in a 100 millisecond interval defines the peak capability of the transponder. The transponder must be capable of replying to this short term burst rate, but may not be capable of sustaining this rate. If the transponder is subjected to interrogation rates beyond its reply rate capability, the reply rate limit control of §2.2.7.3.1 acts to gracefully desensitize the transponder in a manner that favors closer interrogators. Desensitization eliminates weaker interrogation signals.*

(**1.5**) In RTCA DO-181D, in section §2.2.4.2.5.b, insert the text as described below:

b. At all RF input levels from MTL to -21 dBm, the first preamble pulse of the reply **shall** occur 128 ±0.5 microseconds after the leading edge of the P4 pulse of the ATCRBS/Mode S All-Call interrogation. At all RF input levels from MTL +3 dB to -21 dBm, the jitter of the reply delay **shall not** exceed ±0.1 microsecond, peak (99.9 percentile).

(**1.6**) In RTCA/DO-181D, in section §2.2.10.2, replace the contents of the paragraph with the following edited text:

A squitter monitor **shall** be provided to verify that the Mode S transponder generates short and Extended Squitters at their nominal rates (see §2.2.18.2.6 and §2.2.23.1). Event Driven Squitter rates are not required to be monitored to meet this requirement. The transponder **shall** be considered failed when the monitor has detected squitter failure.

(**1.7**) In RTCA DO-181D, in section §2.2.13.1.2, in order to strengthen the Flight ID requirements such that the display and crew entry must be simple to access and modify while on the ground or during flight, make the following changes to subparagraph "e:"

e. If the aircraft uses a flight number for aircraft identification, a means **shall** be provided for the variable aircraft identification to be inserted by the pilot while on the ground, or during flight. The means for modifying and displaying aircraft identification **shall** be a simple crew action independent of the entry of other flight data.

 © 20xx, RTCA, Inc.

(**1.8**) In RTCA/DO-181D, in section §2.2.18.2.1.c in order to correct a bad paragraph reference to the function G(x), make the following correction:

Replace "G(x) is defined in 2.2.16.2.1 b. " **with** "G(x) is defined in §2.2.18.2.1.b"

(**1.9**) In RTCA/DO-181D, in section §2.2.19.1, replace the contents of bullets "a," "b," and "c" with the following edited text:

a. Process uplink and downlink formats DF=16, UF=DF=~~16,~~ 20 and 21 (Figure 2-14). The format~~s~~ UF=~~DF=~~16 ~~are~~ is optional:

Note: ~~*DF=16 is available in transponders supporting Crosslink capability (see §2.2.14.4.7).*~~ *UF=16 is supported by transponders connected to an on-board operational TCAS (see §2.2.20).*

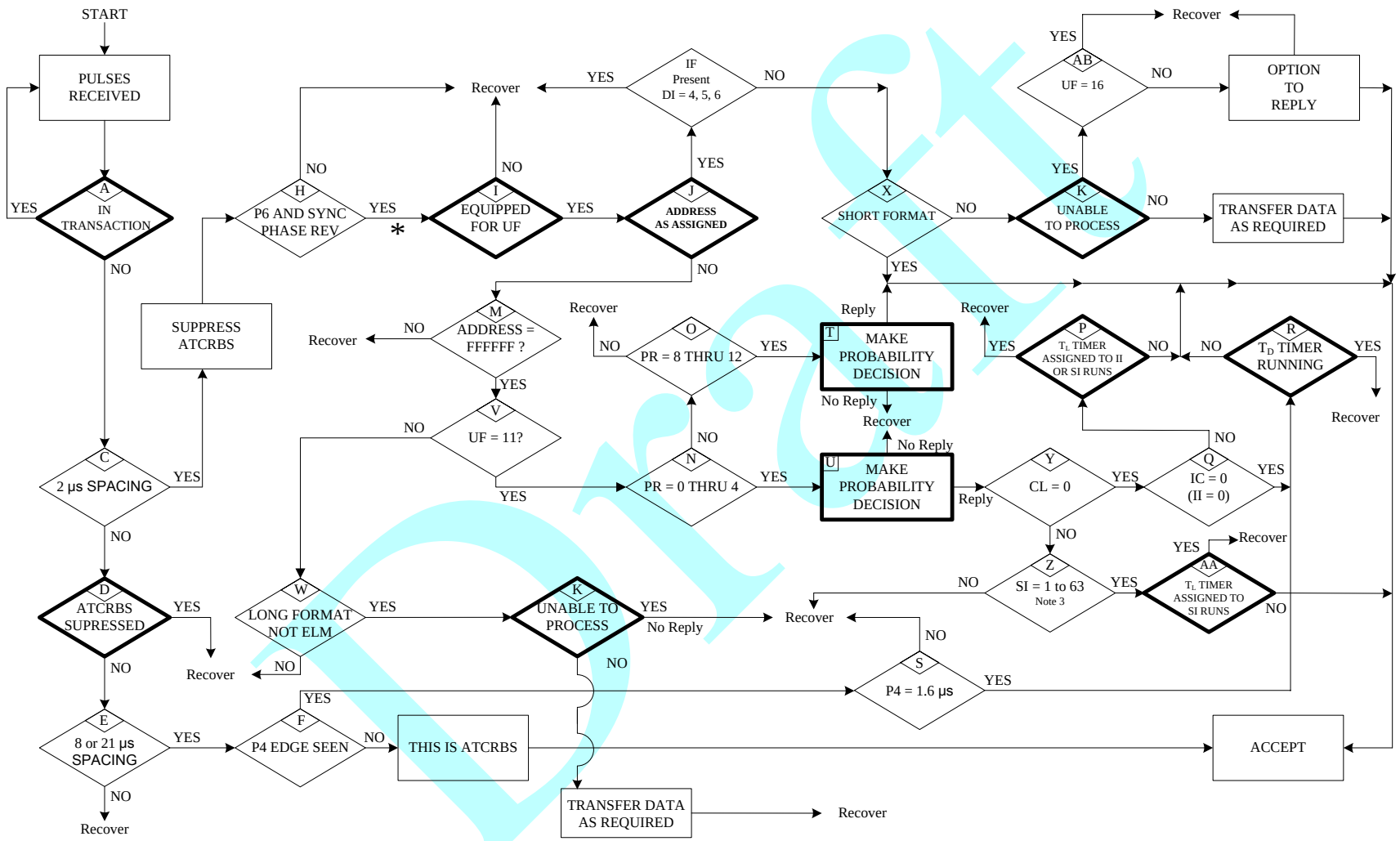
b. Receive broadcast transmissions from sensors (§2.2.19.1.11).

c. Follow the protocols for:

Comm-A (see §2.2.19.1.10).
Comm-B (see §2.2.19.1.12).
Comm-U/V (air-air) (see §2.2.19.1.16) ~~(optional)~~.
Multisite message operation (see §2.2.19.2).
Report Codes 4 through 7 in the CA field (see §2.2.14.4.6).
TCAS crosslink capability (see §2.2.19.1.18).

Draft

(**1.10**) In RTCA/DO-181D, in section §2.2.19.1, in order to clarify how a transponder should respond when the DI field contains an undefined value, replace Figure 2-15 with the following:



 © 20xx, RTCA, Inc.

(**1.11**) In RTCA DO-181D, in section §2.2.19.1.1, in order to clarify how a transponder should respond when the DI field contains an undefined value, add bullet "d" to paragraph §2.2.19.1.1 as follows:

d. When the DI field equals 4, 5 or 6, the interrogation **shall not** be accepted.

(**1.12**) In RTCA/DO-181D, in section §2.2.19.1.4, replace the first table with the table below and add a new *Note* below the table as follows:

Interrogation	**Reply**
ATCRBS Mode A (see Note)	4096 Code
ATCRBS Mode C (see Note)	Altitude Code
ATCRBS/Mode S All-Calls (see Note)	DF=11
UF=4 and UF=5	as below
UF=11 (see Note)	DF=11
UF=20 and UF=21	as below
Broadcast	None

Note: *The transponder does not reply when the conditions of §2.2.18.2.3 apply.*

(**1.13**) In RTCA/DO-181D, in section §2.2.19.1.11, in the first sentence of the paragraph, in order to correct a bad reference:

Change §2.2.18.2.2 **to** §2.2.19.1.1

(**1.14**) In RTCA/DO-181D, in section §2.2.19.1.18, in order to correct a bad paragraph reference, and also make revisions related to the GICB revisions discussed in Working Paper TSG WP08-02R1, revise the paragraph as follows:

In response to a UF=0 with RL=1 (see §2.2.14.4.33) and DS≠0 (see §2.2.14.4.13), the transponder **shall** reply with a DF=16 reply in which the MV field **shall** contain the contents of the ground-initiated Comm-B register designated by the DS value. If the requested Register is not supported by the aircraft installation, then the transponder **shall** reply with an MV field containing ALL ZEROs. In response to a UF=0 with RL=1 and DS=0, the transponder **shall** reply with a DF=16 with an MV field of ALL ZEROs. Receipt of a UF=0 with DS≠0, but RL=0 **shall** have no associated TCAS crosslink action, and the transponder **shall** reply per §2.2.14.4.33.

SC209/WG49-WP11-17 DRAFT Change 1 to DO-181D

(**1.15**) In RTCA/DO-181D, in section §2.2.23.1.2, in order to retain consistency with the terminology used in the ADS-B MOPS and ICAO SARPs, in existing bullet "c" change references to the aircraft identification squitter as follows:

c. Aircraft Identification and Category Squitter. The aircraft identification and category 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 and category report in its MB field.*

(**1.16**) In RTCA/DO-181D, in section §2.2.23.1.2, insert new bullets "e" and "f" to define the Target Status and Status, and the Aircraft Operational Status Messages as Periodic Status Messages and not included any further as "Event-Driven" Messages. Re-label the old bullet "e" to become "g."

e. Target State and Status. The 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=22 (16 HEX), DI=7 and RRS=2 will cause the resulting reply to contain the Target State and Status report in its MB field.*

f. Aircraft Operational Status. The 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=22 (16 HEX), DI=7 and RRS=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=16, DI=7 and RRS= 0A will cause the resulting reply to contain the event-driven report in its MB field.*

 © 20xx, RTCA, Inc.

(**1.17**) In RTCA/DO-181D, in section §2.2.23.1.3, in order to harmonize this section with the requirements specified in RTCA DO-181D, §2.2.23.1.3, replace existing bullet "a" with the following:

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, target state and status, aircraft operational status and aircraft identification and category when data are inserted into GICB Registers 05_{16}, 06_{16}, 09_{16}, 62_{16}, 65_{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 05_{16} and 06_{16} ~~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.

(**1.18**) In RTCA/DO-181D, in section §2.2.23.1.3, in order to establish transmission rates for the Periodic Status Messages, insert new bullets "f" and "g" to define the Target State and Status, and the Aircraft Operational Status squitters, which are not included any further as "Event-Driven" squitters. Re-label the old bullets "f" and "g" to become bullets "h" (Event-Driven Squitter Rate) and "i" (Delayed Transmission) In existing bullets "b," "c," "d," and "e" at the end of each subparagraph, and in the existing paragraph for "Event-Driven Squitter Rate," change the reference for subparagraph "g" to subparagraph "i."

f. Target State and Status Squitter Rate. The Target State and Status squitter shall be initiated only when the aircraft is airborne and when target state information is available and valid as a minimum. The Target State and Status squitter shall be transmitted 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 squitter for as long as valid data is available, with the exceptions as specified in subparagraph "i."

g. Aircraft Operational Status Squitter Rate. The Aircraft Operational Status squitter shall be transmitted at the rates as specified in §2.2.3.3.1.4.2 of RTCA DO-260B/EUROCAE ED-102A, with the exceptions as specified in subparagraph "i." When transmitting the surface formats, the rate depends on whether the high or low squitter rate has been selected (see §2.2.23.1.6).

(**1.19**) In RTCA/DO-181D, in section §2.2.23.1.4.2, in order to clarify the termination of squittering, replace the entire section with the following edited section:
➔ Bob Saffell and Eric Potier have to review and modify to coordinate with DO-260B ➔

The transponder **shall** clear all 56-bits of the airborne position~~,~~ and surface position~~, squitter status and velocity~~ GICB Registers 05_{16}~~,~~ and 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.

The transponder **shall** clear all 56-bits of the velocity squitter, GICB Register 09_{16} if input data necessary to update the subfields of the velocity squitter, other than the Intent Change Flag, is not available for a period of 2.6 seconds.

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.*

(**1.20**) In RTCA/DO-181D, in section §2.2.23.1.5.1, replace the paragraph with the following:

The criteria for selection of airborne or surface formats are contained in the latest version of RTCA/DO-260~~A~~B [EUROCAE ED-102A], §2.2.3.2.1.2.

 © 20xx, RTCA, Inc.

(**1.21**) In RTCA/DO-181D, in section §2.2.23.1.7, as specified in TSG Working Paper TSG09-03, in order to comply with the ICAO SARPs changes to provide ground control to inhibit ATCRBS and Mode S All-Call replies primarily for aircraft without a squat switch, make revisions to the TCS paragraph and TCS coding description table as follows:

The SD field contains the following information if the DI code is 2:

TCS, the 3-bit (bits 21 – 23) Type Control Subfield in SD **shall** control the position type reported by the transponder and its response to ATCRBS, ATCRBS/Mode S All-Call and Mode S-Only All-Call interrogations. These commands **shall** only affect the format type reported, they **shall not** change the aircraft determination of its on-the-ground condition. The commands for codes 1 and 2 **shall** be able to refreshed for a new period before timeout of the prior period.

Note 1: *Thus aircraft without the means to set the on-the-ground condition will continue to report code 6 in the CA field, and an aircraft with the means to set the on-the-ground condition that has determined that it is in the airborne state will continue to set code 5, independent of the Extended Squitter format that is emitted.*

The following TCS codes have been assigned:

TCS Codes	Description
0	No position type command
1	Use surface position type and inhibit replies to ATCRBS, ATCRBS/Mode S All-Call and Mode S-Only All-Call interrogations for the next 15 seconds
2	Use surface position type and inhibit replies to ATCRBS, ATCRBS/Mode S All-Call and Mode S-Only All-Call interrogations for the next 60 seconds
3	Cancel surface type command and the command to inhibit replies to ATCRBS, ATCRBS/Mode S All-Call and Mode S-Only All-Call interrogations
4 – 7	~~Not assigned~~ Reserved

(**1.22**) In RTCA/DO-181D, in section §2.2.23.1.8 there is an incorrect paragraph reference that must be corrected just below the SSS table. Correct the reference in the first sentence as:

"ACS, the 12-bit (bits 41 52) Altitude Code Subfield in ME **shall** (under control of the ATS subfield, §2.2.23.1.9)

(**1.23**) In RTCA DO-181D. in section §2.2.23.2, since the Target State and Status and the Aircraft Operational Status Messages have been moved out from under the Event-Drive protocol, replace this section with the following:

The Event-Driven Squitter is broadcast each time data is loaded into GICB Register $0A_{16}$ as specified in §2.2.23.1.3. The transponder also makes available GICB Registers related to

the Extended Squitter Event-Driven Squitter. The transponder shall provide data to the appropriate GICB Registers that are loaded into the Event-Driven GICB Register $0A_{16}$.

The following GICB Registers are defined for the Event-Driven Squitter:

BDS Code 6,1 Extended Squitter Emergency/Priority Status
~~BDS Code 6,2 Target State and Status~~
~~BDS Code 6,5 Extended Squitter Aircraft Operational Status~~

Note: Additional information on the data content and transmission of these Extended Squitter Messages can be found in the latest version of RTCA/DO-260B.

(**1.24**) In RTCA/DO-181D. in section §2.2.23.4 in order to comply with the changes in transmission rates made in DO-260B/ED-102A for Event-Driven Messages, add the following to the end of the first paragraph:

The maximum total number of Extended Squitters (DF=17, 18 or 19) emitted by any Extended Squitter installation **shall not** exceed 6.2 per second averaged over any 60 second interval.

(**1.25**) In RTCA/DO-181D, in section §2.2.24.3.2.2, in order to account for the changes that are being made in the ADS-B MOPS (RTCA DO-260B/EUROCAE ED-102A) and subsequent equivalent changes in ICAO Doc 9871, Edition 2, the Mode S Subnetwork Version Number will have to change accordingly. Replace Table 2-4 with the following:

Version Number	**ICAO**	**RTCA**	**EUROCAE**
0	Mode S Subnetwork Not Available		
1	ICAO Doc 9688 (1996)		
2	ICAO Doc 9688 (1998)		
3	Annex 10, Vol III, Amendment 77		
4	ICAO Doc 9871, Edition 1	DO-181D	ED-73C
5	ICAO Doc 9871, Edition 2	DO-181D Change 1	ED-73C Change 1
6–127	~~Unassigned~~ Reserved		

(**1.26**) In RTCA/DO-181D, there are numerous occasions where the phrase "Minimum Update Interval" has been incorrectly used, and where the phrase "Maximum Update Interval" should have been used instead. In the requirements description at some of these locations, reference has also been made to the Register Allocation Table in Appendix B, which is incorrectly referenced as Table B-1, and should have been referenced as Table B-2-1. In each of the following paragraph references, **all instances of** "Minimum Update Interval"

 © 20xx, RTCA, Inc.

must be changed to "Maximum Update Interval," and **where references occur** to "Table B-1," **they must be changed to** "Table B-2-1."

§2.2.24.3.3	§2.2.25.1.3	§2.2.25.6.3	§2.7.1.3
§2.2.24.5.3	§2.2.25.2.2.7	§2.2.25.7.3	§2.7.2.2.7
§2.2.24.6.3	§2.2.25.3.3	§2.2.25.8.3	§2.7.3.3
§2.2.24.7.3	§2.2.25.5.3	§2.2.26.3	§2.8.3

(**1.27**) In RTCA/DO-181D, in section §2.2.24.6.2.1, in order to resolve the coordination of documents with regard to the issue of timeout issues related to Registers 08_{16} and 20_{16} initially raised by Kevin Wilson of Honeywell and discussed in Working Paper SC209-WP10-04 by Bob Saffell of Rockwell Collins, change the first *Note* in §2.2.24.6.2.1 to read as follows:

Note: *Aircraft Registration Data may also be used in Register 08_{16} when Extended Squitter is implemented. As such, the Data Selection requirements inferred below will also apply to Register 08_{16} when Extended Squitter is implemented.*

(**1.28**) In RTCA/DO-181D, in section §2.2.24.6.2.1.b, to correct a minor typographical error, in the *Note* following subparagraph "b":

Replace "(Datal Link Capability Report)" **with** "(Data Link Capability Report)"

(**1.29**) In RTCA/DO-181D, in section §2.2.24.6.2.1.c, in order to resolve the coordination of documents with regard to the issue of timeout issues related to Registers 08_{16} and 20_{16} initially raised by Kevin Wilson of Honeywell and discussed in Working Paper SC209-WP10-04 by Bob Saffell of Rockwell Collins, add the following *Note* directly after section §2.2.24.6.2.1.c:

***Note**: Register 08_{16} is not cleared when Extended Squitter is implemented since this Register is used to provide Flight Identification information for the ADS-B environment.*

(**1.30**) In RTCA/DO-181D, in section §2.2.24.6.2.1.d, to correct a minor typographical error in bullet (3) of subparagraph "d":

Replace the word "conatain" **with** "contain"

(**1.31**) In RTCA/DO-181D, in section §2.2.24.6.3.b, correct a minor typographical error by deleting the second use of the word "of."

(1). The contents of ~~of~~ the character field of Register 20_{16} shall be set to ZERO (0).

(**1.32**) In RTCA/DO-181D, in section §2.2.24.6.4.2, in order to correct a cut-and-paste error in a bit reference, replace the only sentence in the section with the following correction:

"Correct servicing of the character fields of Register 20_{16} **shall** be reported in Register 17_{16} via bit ~~33~~ 7 as defined in §2.2.24.4.2.1."

(**1.33**) In RTCA/DO-181D, in section §2.2.25.8.3, in order to correct references to the "maximum update interval" as detailed in Appendix B, Table B-2-1, and to also correct the specific maximum update interval for Register 60_{16}, which is specified in Table B-2-1 as 1.3 seconds, make the changes identified below in yellow to replace the word "minimum" with the word "maximum," and replace the actual values for the Register 60_{16} maximum update interval as indicated:

a. The maximum update interval at which Register 60_{16} **shall** be reloaded with valid data is 1.3 seconds.
   Note: *Register 60_{16} is updated at least once every 1.3 second.*
b. The time between availability of data that causes a change in Register 60_{16} and the time that the change is made to Register 60_{16} **shall** be less than the maximum update interval specified as 1.3 seconds.
c. If Magnetic Heading data in Register 60_{16} "MB" field bits 2 through 12 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified maximum update interval of 1.3 seconds) then Status Bit 1 shall be set to ZERO (0) and bits 2 through 12 **shall** be set to ZERO (0).
d. If Indicated Airspeed data in Register 60_{16} "MB" field bits 14 through 23 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified maximum update interval of 1.3 seconds) then Status Bit 13 shall be set to ZERO (0) and bits 14 through 23 **shall** be set to ZERO (0).
e. If Mach data in Register 60_{16} "MB" field bits 25 through 34 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified maximum update interval of 1.3 seconds) then Status Bit 24 shall be set to ZERO (0) and bits 25 through 34 **shall** be set to ZERO (0).
f. If Barometric Altitude Rate data in Register 60_{16} "MB" field bits 36 through 45 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified maximum update interval of 1.3 seconds) then Status Bit 35 **shall** be set to ZERO (0) and bits 36 through 45 shall be set to ZERO (0).
g. If Inertial Vertical Rate data in Register 60_{16} "MB" field bits 47 through 56 cannot be updated with valid data within 2.6 seconds (e.g., twice the specified maximum update interval of 1.3 seconds) then Status Bit 46 **shall** be set to ZERO (0) and bits 47 through 56 shall be set to ZERO (0).

 © 20xx, RTCA, Inc.

(**1.34**) In RTCA/DO-181D, in section §2.2.26.3, in order to correct references to the "maximum update interval" as detailed in Appendix B, Table B-2-1, and to also correct the specific references to the actual Table in Appendix B, make the changes identified below in yellow to replace the word "minimum" with the word "maximum," and replace the Table reference with "Table B-2-1" as indicated below:

a. The maximum update interval at which a data field in a Register will be reloaded with valid data is defined for each register in Table B-2-1 in Appendix B.

b. The transponder will load valid data into the related transponder Register as soon as it becomes available at the Mode S Specific Services entity.

c. The time between availability of data that causes a change in a data-field of a Register and the time that the change is made to the Register will be less than the maximum update interval specified in Table B-2-1 in Appendix B.

d. If a data-field field cannot be updated with valid data within twice the specified maximum update interval defined for the Register, or 2 seconds (whichever is the greater), then the Status Bit (if specified) of the field will be set to ZERO (0) (INVALID) and that data field will be ZEROed.

(**1.35**) In RTCA/DO-181D, in section §2.5.4.6.2.2, replace the second paragraph with the following:

Verify the content of the CA, AA and PI fields of all Extended Squitter replies. For the following test, connect the transponder to the appropriate source that provides altitude code input to the transponder. Also, as required, setup to provide Extended Squitter data to ground initiated Comm-B Registers 05_{16}, 06_{16}, 07_{16}, 08_{16}, 09_{16} , ~~and~~ $0A_{16}$, 62_{16} and 65_{16} through an external interface as specified in §2.2.13.2.

(**1.36**) In RTCA/DO-181D, in section §2.5.4.6.2.2, in Step 3, make the following changes in the first three lines of the test procedure:

Step 3 Provide Extended Squitter updates to the transponder at a ~~rate~~ maximum update interval as specified in Appendix B, Table B-2-1. Include updates to GICB Registers 05_{16}, 06_{16}, 07_{16}, 08_{16} ~~and~~ 09_{16}, 62_{16} and 65_{16}.

(**1.37**) In RTCA/DO-181D, in section §2.5.4.6.2.2, in Step 4, make the following changes:

Step 4 Set up the transponder as in Step 3 with Extended Squitter updates to the transponder at a ~~rate~~ maximum update interval as specified in Appendix B, Table B-2-1. Place the transponder in the airborne state. Stop updates of all Extended Squitter data, except altitude information, to the transponder for GICB Registers

05_{16}, 06_{16}, 07_{16}, 08_{16}, ~~and~~ 09_{16}, 62_{16} and 65_{16}. Verify that after 2 seconds, ~~all subsequent~~ the Extended Squitter ME fields for ~~(~~GICB Registers 07_{16}, ~~and 09_{16})~~ 62_{16} and 65_{16} are ZERO with the exception of the ACS field in the airborne position squitter (GICB Register 05_{16}) and the airborne identification squitter (GICB Register 08_{16}). Verify that after 2.6 seconds the airborne velocity squitter is not being transmitted. Place the transponder in the ground state and verify that the surface position Extended Squitter ME field (GICB Register 06_{16}) is ZERO. Repeat the setup as in Step 3 with Extended Squitter updates to the transponder at a one half second rate. Place the transponder in the airborne state. Interrogate the transponder with RR=17 and DI=7 and verify that the SCS subfield of the data link capability report is one. After all updates (except altitude information) have ceased for 10 seconds, interrogate to extract the data link capability report and verify that the SCS subfield is ZERO. Interrogate the transponder with ground initiated Comm-B requests with RR=16, DI=7 and RRS=5, 6, 7, 8 and 9 respectively. Verify that the MB fields are ZERO with the exception of the ACS field in the airborne position squitter (GICB Register 05_{16}) and the airborne identification squitter (GICB Register 08_{16}). After all updates (except altitude information) have ceased for 60 seconds, verify that airborne identification ~~and airborne velocity~~ Extended Squitters are no longer transmitted. Place the transponder in the ground state and verify that the surface position Extended Squitter (GICB Register 06_{16}) is no longer transmitted. Return the transponder to the airborne state. Verify that the acquisition squitter and airborne position squitter are broadcast. Set the ALT switch to the "off" position. Verify that the ME field of the airborne position squitter is ZERO. After 60 seconds, verify that the transponder no longer broadcasts airborne position squitters.

(**1.38**) In RTCA/DO-181D, in section §2.5.4.6.2.2, in Step 5, make the following changes in the first three lines of the test procedure:

Step 5 Set the ALT switch to the "on" position and provide altitude code input to the transponder. Provide Extended Squitter updates to the transponder at a ~~rate~~ maximum update interval as specified in Appendix B, Table B-2-1.

(**1.39**) In RTCA/DO-181D, in section §2.5.4.6.2.2, in Step 6, make the following changes:

Step 6 Set the ALT switch to the "on" position and provide altitude code input to the transponder. Provide Extended Squitter updates to the transponder at a ~~rate~~ maximum update interval as specified in Appendix B, Table B-2-1. Include updates to GICB Registers 05_{16}, 06_{16}, 07_{16}, 08_{16} and 09_{16}. Verify that the ME fields of the airborne position, velocity and aircraft identification squitters match the data input. Stop updates of Extended Squitter data to the transponder for GICB Registers 08_{16} and 09_{16} only. After 2.6 seconds, verify that the ~~ME field of the~~ airborne velocity squitter is ~~ZERO~~ no longer transmitted. Interrogate with RR=16, DI=7 and RRS=5, 6, 8 and 9 and verify that the MB fields match the ME fields in

 © 20xx, RTCA, Inc.

the corresponding Extended Squitter reply. After 10 seconds, interrogate to extract the data link capability report and verify that SCS is one. After 60 seconds, verify that airborne position reports are still transmitted and that aircraft identification and airborne velocity squitters are not transmitted.

(**1.40**) In RTCA/DO-181D, in section §2.5.4.6.2.2, in Step 7, make the following changes:

Step 7 Configure the transponder to inhibit Acquisition squitters when Extended Squitters are broadcast. Prior to providing Extended Squitter updates, verify that Acquisition squitters are broadcast. Provide Extended Squitter updates at a ~~rate~~ maximum update interval as specified in Appendix B, Table B-2-1 to GICB Registers 05_{16}, 06_{16} and 08_{16} and provide altitude code input to the transponder. Verify that Extended Squitters are broadcast and Acquisition squitters are not broadcast. Verify that airborne position and aircraft identification squitters are broadcast at the proper rate and alternately on the top and bottom antenna ports as specified for airborne state if antenna diversity is supported. Additionally provide updates to GICB Register 09_{16}. Verify the broadcast of airborne position squitters, aircraft identification squitters and airborne velocity squitters at the proper rate and the ME data content matches the data stored in GICB Registers 05_{16}, 08_{16} and 09_{16}, respectively. Verify that the transponder does not broadcast Acquisition squitters.

Set the ALT switch to the "off" position and stop update to GICB Registers 05_{16}, 06_{16}, 08_{16} and 09_{16}. After 2 seconds, verify that the ME field~~s~~ of the airborne position ~~and airborne velocity~~ squitters ~~are~~ is ZERO. After 2.6 seconds, verify that the airborne velocity squitter is no longer transmitted. Interrogate with UF=4, RR=16, DI=7 and RRS=5, 6, 8 and 9, respectively. Verify that the MB fields of the replies match the data of the corresponding Extended Squitter reply. After 60 seconds, verify that Extended Squitter airborne position squitter transmissions stop and the transponder resumes Acquisition squitter broadcast.

Repeat above sequence except stop update to GICB Registers 05_{16} and 06_{16} only. After 2 seconds, verify that the ME field of the airborne position report is ZERO. After 60 seconds, verify that the transponder no longer broadcasts airborne position squitters and continues to broadcast airborne velocity and aircraft identification squitters. Verify that the transponder continues to inhibit the broadcast of Acquisition squitters.

Repeat above except stop update to GICB Register 09_{16} only. After 2.6 seconds, ~~Again,~~ verify that ~~after 2 seconds the ME field of~~ the airborne velocity squitter is ~~ZERO~~ no longer transmitted, and after 60 seconds, ~~both airborne velocity and~~ verify that the Acquisition squitters are not transmitted.

(**1.41**) In RTCA/DO-181D, in section §2.5.4.6.2.2, in Step 8, make the following changes:

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 Extended Squitter 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.

(**1.42**) In RTCA/DO-181D, in section §2.5.4.6.2.2, in Step 10, make the following changes in the initial lead-in paragraph:

Step 10 Provide Extended Squitter updates to the transponder at a rate as specified in Appendix B, Table B-2-1. Include updates to GICB Registers 05_{16}, 06_{16}, 08_{16} ~~and~~ 09_{16} , 62_{16} and 65_{16}. Use other than ZERO or all ONEs for the surface position report and the aircraft identification report. Set TRS to ZERO. For transponders that support automatic on-the-ground detection, perform the following:

(**1.43**) In RTCA/DO-181D, in section §2.5.4.13.b, in order to clarify which specific Timers are being referenced, replace the text of the first paragraph with the following:

The transponder can be in 79 different specific lockout states as determined by the running of the one T_D and the 78 T_L timers. The following test sequence must be repeated for each of the lockout states:

 © 20xx, RTCA, Inc.

(**1.44**) In RTCA/DO-181D, in several sections in §2.6.6 there are references to ICAO Annex 10, Volume III, Part 1, Amendment 71. With this Change document, these references to specific Amendments will be removed, so as not to require updates in the future. Remove references to ICAO Annex 10 Amendments in the following locations:

§2.6.6.1.a.(1) Note 2 inside the Table
§2.6.6.1.a.(2) Note 1 inside the Table
§2.6.6.5.a.(1) Note 2 inside the Table
§2.6.6.5.a.(2) Note 1 inside the Table
§2.6.6.6.a.(1) Note 2 inside the Table
§2.6.6.6.a.(2) Note 1 inside the Table

(**1.45**) In RTCA/DO-181D, in section §2.8.4, in bullets "a" and "b," in order to correct a problem with Table references in Appendix B, make the following changes identified below in yellow:

a. Verify that the servicing of Register $\mathbf{XX_{16}}$ during the power-on cycle of the transponder is properly reported in Registers 18_{16} through $1C_{16}$ as required in Appendix B, Table B-3-24 to Table B-3-28.

b. Verify that the real-time (not just since power-on) servicing of Register $\mathbf{XX_{16}}$ is properly reported in Register 17_{16} (see Appendix B, Table B-3-23) if such reporting is required for Register $\mathbf{XX_{16}}$.

(**1.46**) In RTCA/DO-181D, in section §3.3.3, there is a discrepancy with the same paragraph §6.4.4.1 in ED-73C. In order to harmonize DO-181D with ED-73C, make the following changes:

Interrogate the installed transponder and verify that the reply frequency of the system is 1090 ±~~3~~ 1 MHz ~~for aircraft operating below 15,000 feet, or 1090, ±1 MHz for aircraft operating above 15,000 feet~~.

(**1.47**) In RTCA/DO-181D, in Appendix A, section §A.1, add the following acronyms:

QFE – Aviation "Q" Code for "Field Elevation"
QNE – Aviation "Q" Code for "Nautical Height" for Enroute
QNH – Aviation "Q" Code for "Nautical Height"

(**1.48**) In RTCA/DO-181D, in Appendix A, section §A.2, edit and add the following definitions:

Event-Driven – Messages that are broadcast periodically for a duration of the operational condition. Examples of Event-Driven Messages include the Extended Squitter Aircraft Status Message with the Emergency/Priority Status and TCAS RA Broadcast subtypes,

~~Operational Status and Target State and Status Messages~~ (ref. RTCA/DO-260~~A~~ B/EUROCAE ED-102A).

Periodic Status – Status Messages that are broadcast independently in the same manner as the Airborne Position, Surface Position, Airborne Velocity and Aircraft Identification Messages. Examples of Periodic Status Messages include the Target State and Status and the Aircraft Operational Status (ref. RTCA DO-260B/EUROCAE ED-102A).

QFE – Local station barometric pressure setting which provides an altimeter reading of indicated altitude of the airplane above the station, whether airborne or on the ground.

QNE – The barometric pressure used for the standard altimeter setting (29.92 inches Hg).

QNH – Local station barometric pressure setting which provides an altimeter reading of indicated altitude of the airplane above mean sea level, whether airborne or on the ground.

(**1.49**) In RTCA/DO-181D, in Appendix B, there are several references to ICAO Doc 9871, Edition 1. There are specific paragraph references to guidance materials in Doc 9871, Edition 1, Appendix C, which will change to Appendix D in Doc 9871, Edition 2. In the titles of the following subparagraphs in Appendix B, make the specified changes to the paragraph reference which will exist in ICAO Doc 9871, Edition 2:

In the title of §B.4.1 **change** §C.2.4.1 **to** §D.2.4.1
In the title of §B.4.2 **change** §C.2.4.2 **to** §D.2.4.2
In the title of §B.4.3 **change** §C.2.4.3 **to** §D.2.4.3
In the title of §B.4.4 **change** §C.2.4.4 **to** §D.2.4.4
In the title of §B.4.5 **change** §C.2.4.5 **to** §D.2.4.5
In the title of §B.4.6 **change** §C.2.4.6 **to** §D.2.4.6

 © 20xx, RTCA, Inc.

(1.50) In RTCA/DO-181D, in section §B.3 just prior to Table B-3-7 there is an un-numbered table containing references to "ADS-B Registers." Because of the changes in RTCA DO-260B and EUROCAE ED-102A defining the ADS-B Periodic Status Messages and removing them from being broadcast by the Event-Driven protocol, edit the text, the un-numbered table and the *Note* just prior to Table B-3-7 as follows:

For additional information on the following ADS-B Registers, please reference RTCA/DO-260~~A~~ B/EUROCAE ED-102A:

Table B-3-5	BDS Code 0,5	Extended Squitter Airborne Position
Table B-3-6	BDS Code 0,6	Extended Squitter Surface Position
Table B-3-7	BDS Code 0,7	Extended Squitter Status (see *Note*)
Table B-3-8	BDS Code 0,8	Extended Squitter Aircraft Identification and Category
Table B-3-9a	BDS Code 0,9	Extended Squitter Airborne Velocity (Subtypes 1 and 2 – Velocity Over Ground)
Table B-3-9b	BDS Code 0,9	Extended Squitter Airborne Velocity (Subtypes 3 and 4 – Airspeed and Heading)
Table B-3-10	BDS Code 0,A	Extended Squitter Event-Driven Information
Table B-3-97-1	BDS Code 6,1	Extended Squitter Aircraft Status (see *Note*) (Subtype =1 – Emergency/Priority Status)
Table B-3-97-2	BDS Code 6,1	Extended Squitter Aircraft Status (see *Note*) (Subtype=2 – TCAS RA Broadcast)
Table B-3-98	BDS Code 6,2	Target State and Status
Table B-3-101	BDS Code 6,5	Extended Squitter Aircraft Operational Status

Note: *The 1090 Extended Squitter Status Registers are actually provided in this section since they are not squittered and intended to be accessed through GICB protocols.*

(1.51) In RTCA/DO-181D, in section §B.2.1, in order to resolve the coordination of documents with regard to the issue of timeout issues related to Registers 08_{16} and 20_{16} initially raised by Kevin Wilson of Honeywell and discussed in Working Paper SC209-WP10-04 and SC209-WP11-04 by Bob Saffell of Rockwell Collins, add the following *Note* directly after the first paragraph in section §B.2.1, prior to Table B-2-1:

***Note**: If Extended Squitter is implemented, then Register 08_{16} **is not** be 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_{16} **is not** cleared since it provides information that is fundamental to track file management in the ADS-B environment.*

(1.52) In RTCA/DO-181D, in section §B.3, Table B-3-16 describes the format for Register 10_{16}. In order to account for the changes that were made in the ADS-B MOPS (RTCA DO-260B/EUROCAE ED-102A) and subsequent corresponding changes being proposed in ICAO Doc 9871, Edition 2, the following additional reference should be added in Note #1 of Table B-3-16:

1) Annex 10 Volume IV, §3.1.2.6.10.2 and §4.3.8.4.2.2.2.

(**1.53**) In RTCA/DO-181D, in section §B.3, Table B-3-16 describes the format for Register 10_{16}. In order to account for the changes that were made in the ADS-B MOPS (RTCA DO-260B/EUROCAE ED-102A) and subsequent corresponding changes being proposed in ICAO Doc 9871, Edition 2, the definition of the Mode S Subnetwork Version Number in RTCA DO-181D and EUROCAE ED-73C will have to change accordingly. Replace the description of the Mode S Subnetwork Version Number field, Bits 17 through 23, in *Note* #12 of Table B-3-16 with the following:

Version Number	**ICAO**	**RTCA**	**EUROCAE**
0	Mode S Subnetwork Not Available		
1	ICAO Doc 9688 (1996)		
2	ICAO Doc 9688 (1998)		
3	Annex 10, Vol III, Amendment 77		
4	ICAO Doc 9871, Edition 1	DO-181D	ED-73C
5	ICAO Doc 9871, Edition 2	DO-181D Change 1	ED-73C Change 1
6–127	~~Unassigned~~ Reserved		

(**1.54**) In RTCA/DO-181D, in section §B.3, Table B-3-23, in order to harmonize the naming of the Extended Squitter Identification and Category Message across all documents, in the definition table for Register 17_{16}, make the following changes for bit #4:

0,8 Extended Squitter ~~Type and~~ Identification and Category

(**1.55**) In RTCA/DO-181D, in section §B.3, Table B-3-48, Note 1 has an incorrect reference:

In Note 1 of Table B-3-48 **replace** §2.2.22.1.2.1.3 **with** §2.2.22.1.2.1

 © 20xx, RTCA, Inc.

(**1.56**) In RTCA/DO-181D, in section §B.3, Table B-3-97-1 it is necessary to reflect the addition of the Mode A Code to the format for the Aircraft Status Message for Subtype=1 broadcasting the Emergency/Priority status and the Mode A Code. Replace Table B-3-97-1 with:

1	MSB
2	
3	FORMAT TYPE CODE = 28
4	
5	LSB
6	MSB
7	SUBTYPE CODE = 1
8	LSB
9	MSB
10	EMERGENCY STATE
11	LSB
12	MSB
13	
14	
15	
16	
17	MODE A (4096) CODE
18	
19	
20	
21	
22	
23	
24	LSB
25	
26	
27	
28	
29	
30	
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	RESERVED
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	

PURPOSE: To provide additional information on aircraft status.

Subtype shall be coded as follows:

0 = No information
1 = Emergency/priority status and Mode A Code
2 = TCAS RA Broadcast
3 to 7 = Reserved

Emergency state shall be coded as follows:

Value	Meaning
0	No emergency
1	General emergency
2	Lifeguard/Medical
3	Minimum fuel
4	No communications
5	Unlawful interference
6	Downed aircraft
7	Reserved

1) Message delivery shall be accomplished using the Event-Driven protocol as specified in RTCA DO-260B, §2.2.3.3.1.4.3.

2) Termination of emergency state shall be detected by coding in the surveillance status field of the airborne position message.

3) Subtype 2 message broadcast shall take priority over subtype 1 message broadcast.

4) Emergency State value 1 shall be set when Mode A code 7700 is provided to the transponder.

5) Emergency State value 4 shall be set when Mode A code 7600 is provided to the transponder.

6) Emergency State value 5 shall be set when Mode A code 7500 is provided to the transponder.

7) The Mode A Code shall be coded as defined in ICAO Annex 10 Volume IV, §3.1.2.6.7.1.

Draft

(**1.57**) In RTCA/DO-181D, in section §B.3, Table B-3-97-2 in order to harmonize with changes made in RTCA DO-260B/EUROCAE ED-102A, make the following changes to Note #3 in the Register description of the Aircraft Status Message with Subtype=2:

3) RA Broadcast shall be terminated ~~10~~ 24 +/-1 seconds after the RAT flag (Annex 10, Volume IV, §4.3.8.4.2.2.1.3) transitions from ZERO to ONE.

Draft

 © 20xx, RTCA, Inc.

(**1.58**) In RTCA/DO-181D, in section §B.3, Table B-3-98 it is necessary to reflect the revised definition of the Register 62_{16} Target State and Status Information for Subtype=1 as defined in DO-260B/ED-102A for ADS-B Version = 2. Replace Table B-3-98 with the following:

PURPOSE: To provide aircraft state and status information.

1	
2	
3	**FORMAT TYPE CODE = 29**
4	
5	
6	MSB **SUBTYPE CODE = 1**
7	LSB
8	**SIL SUPPLEMENT** (0=Per Hour, 1=Per Sample)
9	**SELECTED ALTITUDE TYPE** (0=MCP/FCU, 1=FMS)
10	MSB = 32768 feet
11	**MCP / FCU SELECTED ALTITUDE**
12	(when Selected Altitude Type = 0)
13	**FMS SELECTED ALTITUDE**
14	(when Selected Altitude Type = 1)
15	Coding: 111 1111 1111 = 65472 feet
16	*** **** ****
17	000 0000 0010 = 32 feet
18	000 0000 0001 = 0 feet
19	000 0000 0000 = No data or Invalid
20	LSB = 32 feet
21	MSB = 204.8 millibars
22	**BAROMETRIC PRESSURE SETTING (MINUS 800 millibars)**
23	Range = [0, 408.0] Resolution = 0.8 millibars
24	Coding: 1 1111 1111 = 408.00 millibars
25	* **** ****
26	0 0000 0010 = 0.800 millibars
27	0 0000 0001 = 0.000 millibars
28	0 0000 0000 = No Data or Invalid
29	LSB = 0.8 millibars
30	STATUS (0=Invalid, 1=Valid)
31	Sign (0=Positive, 1=Negative)
32	MSB = 90.0 degrees
33	
34	**SELECTED HEADING**
35	Range = [+/- 180] degrees, Resolution = 0.703125 degrees
36	(Typical Selected Heading Label = "101")
37	
38	
39	LSB = 0.703125 degrees (180/256)
40	MSB
41	**NAVIGATION ACCURACY CATEGORY for POSITION (NAC_P)**
42	(§A.1.4.9.9)
43	LSB
44	**NAVIGATION INTEGRITY CATEGORY for BARO (NIC_{BARO})**
45	MSB **SOURCE INTEGRITY LEVEL (SIL)**
46	LSB
47	**STATUS of MCP / FCU MODE BITS** (0 = Invalid, 1 = Valid)
48	**AUTOPILOT ENGAGED** (0 = Not Engaged, 1 = Engaged)
49	**VNAV MODE ENGAGED** (0 = Not Engaged, 1 = Engaged)
50	**ALTITUDE HOLD MODE** (0 = Not Engaged, 1 = Engaged)
51	**Reserved for ADS-R Flag** (see §2.2.18.4.6)
52	**APPROACH MODE** (0 = Not Engaged, 1 = Engaged)
53	**TCAS OPERATIONAL** (0 = Not Operational, 1 = Operational)
54	**LNAV MODE** (0 = Not Engaged, 1 = Engaged)
55	MSB RESERVED
56	LSB

Note: This Barometric Pressure Setting data can be used to represent QFE or QNH/QNE, depending on local procedures. It represents the current value being used to fly the aircraft.

Draft

(**1.59**) In RTCA/DO-181D, in section §B.3, Table B-3-101 it is necessary to reflect the revised definition of the Extended Squitter Aircraft Operational Status as defined in DO-260B/ED-102A for ADS-B Version = 2. Replace Table B-3-101 with the following:

1	MSB	
2		
3	FORMAT TYPE CODE = 31	
4		
5	LSB	
6	MSB	MSB
7	SUBTYPE CODE = 0	SUBTYPE CODE = 1
8	LSB	LSB
9	MSB	MSB
10		
11		
12		
13		
14	AIRBORNE	SURFACE
15	CAPABILITY CLASS (CC)	CAPABILITY CLASS (CC)
16	CODES	CODES
17		
18		
19		
20		LSB
21		MSB
22		LENGTH/WIDTH CODES
23		
24	LSB	LSB
25	MSB	MSB
26		
27		
28		
29		
30	AIRBORNE	SURFACE
31	OPERATIONAL	OPERATIONAL
32	MODE (OM) CODES	MODE (OM) CODES
33		
34		
35		
36		
37		
38		
39		
40	LSB	LSB
41	MSB	
42	ADS-B VERSION NUMBER	
43	LSB	
44	NIC SUPPLEMENT-A	
45	MSB	
46	NAVIGATIONAL ACCURACY CATEGORY – POSITION	
47	(NAC_P)	
48	LSB	
49	MSB GVA	RESERVED
50	LSB	
51	MSB SOURCE INTEGRITY LEVEL (SIL)	
52	LSB	
53	NIC_{BARO}	TRK/HDG
54	HRD	
55	SIL SUPPLEMENT	
56	RESERVED for ADS-R	

PURPOSE: To provide the capability class and current operational mode of ATC-related applications and other operational information..

Subtype Coding:

0 = Airborne Status Message
1 = Surface Status Message
2 – 7 = Reserved

Draft

 © 20xx, RTCA, Inc.

(**1.60**) In RTCA/DO-181D, section §B.4.1.3 describes the Mode S Subnetwork Version Number. In order to account for the changes that were made in the ADS-B MOPS (RTCA DO-260B/EUROCAE ED-102A) and subsequent corresponding changes being proposed in ICAO Doc 9871, Edition 2, the definition of the Mode S Subnetwork Version Number in RTCA DO-181D and EUROCAE ED-73C will have to change accordingly. At the beginning of §B.4.1.3, replace the definition of Bits 17 – 23 for the Mode S Subnetwork Version Number with the following:

Bits 17 – 23 reflect the Mode S Subnetwork Version Number.

Version Number	**ICAO**	**RTCA**	**EUROCAE**
0	Mode S Subnetwork Not Available		
1	ICAO Doc 9688 (1996)		
2	ICAO Doc 9688 (1998)		
3	Annex 10, Vol III, Amendment 77		
4	ICAO Doc 9871, Edition 1	DO-181D	ED-73C
5	ICAO Doc 9871, Edition 2	DO-181D Change 1	ED-73C Change 1
6–127	~~Unassigned~~ Reserved		

Draft

THE FOLLOWING IS AN INFORMAL LISTING OF THE ITEMS THAT HAVE BEEN COLLECTED SINCE THE PUBLICATION OF DO-181D/ED-73C AND WHICH WILL BE EXPANDED IN DETAIL INTO THE FORMAT ABOVE FOR EACH SPECIFIC MODIFICATION.

All of those issues that have been implemented above will be highlighted in yellow.

1. Potential change to DO-181D regarding DPSK issue raised verbally by Eric Potier in TSG Paris meeting June 2009 related to Annex 10 Vol IV §3.1.2.1.4.2.1, §3.1.2.1.5.2.5 and Figure 3-1, regarding amplitude variation. A problem of phase modulation interoperability between interrogators and receivers has been reported and the issue was presented to ICAO ASP Working Group meeting in Montreal, September 2009 in WP ASP07-19 and resulted in an Action ASP07-08 to the TSG to investigate and report back to the Working Group. Any DO-181D/ED-73C change will have to come out of any SARPs CP presented by the TSG to the WG, potentially in April 2010 in Montreal.

Fort Lauderdale January 2010 TSG Working Paper TSG WP08-17 by Eric Potier again describes the problem of phase modulation interoperability between interrogators and receivers. This Working Paper, as well as the same presentation to the April 2010 ASP Working Group in ASP WP08-08 contained proposals for SARPs and MOPS changes, the details of which have yet to be completely agreed to. During the Fort Lauderdale TSG Meeting, Bob Saffell identified DO-181D, §2.2.2.3 as a potential place for change, in addition to the paragraphs specified in TSG WP08-17 (and ASP WP08-08) as DO-181D, §2.5.4.1 [Eurocae ED-73C, §5.5.8.1.1].

2. Potential change identified by Vince Orlando regarding Level 2 transponders providing the crosslink capability.

2.2.19.1 Minimum Level 2 Transponder Requirements

The operational functions described in 1.4.3.2 require that this transponder **shall**, in addition to the functions of the Level 1 transponder:

a. Process formats ~~UF=~~DF=16, UF=DF=20 and 21 (Figure 2-14). The format~~s~~ UF =~~DF~~=16 ~~are~~ is optional:

Note: ~~DF=16 is available in transponders supporting Crosslink capability (see 2.2.14.4.7).~~ UF=16 is supported by transponders connected to an on-board operational TCAS (2.2.20)

b. Receive broadcast transmissions from sensors (2.2.19.1.11)

c. Follow the protocols for:

Comm-A (see 2.2.19.1.10)
Comm-B (see 2.2.19.1.12)
Comm-U/V (air-air) (See 2.2.19.1.6) ~~(optional)~~

Multisite message operation (see 2.2.19.2)
Report Codes 4 through 7 in the CA field (see 2.2.14.4.6)

 © 20xx, RTCA, Inc.

TCAS/ACAS crosslink capability (see 2.2.19.1.18)

3. Potential change identified by Don Walker of Honeywell (at the time) in Working Paper 1090-WP28-22R1.

2.2.10.2 Squitter Monitor

A squitter monitor **shall** be provided to verify that the Mode S transponder generates short and Extended Squitters correctly (e.g. low power, corrupt data) and at their nominal rates (see 2.2.18.2.6 and 2.2.23.1). Event Driven Squitter rates are not required to be monitored to meet this requirement. The transponder shall be considered failed when the monitor has detected squitter failure.

4. Extensive potential changes identified by Eric Potier in Working Paper 1090-WP28-25R2 to deal with the changes in starting and ending squittering where he wants to specify the timeout values for each 1090ES Message individually, and to correct some update rates.

5. Paragraph reference typo in 2.2.19.1.18,
where: "...and DS ≠0 (see §2.2.14.4.9), the..."
should be: "...and DS ≠0 (see §2.2.14.4.13), the..."

6. Extensive potential changes identified by Vince Orlando and Tom Pagano in Working Paper ASP07-03R1 presented as SARPs CP for the ground commanding the aircraft into the on-the-ground status. Identified mainly for aircraft without squat switch.

7. As part of the FRAC/WC Process for the draft of DO-260B/ED-102A, a comment was raised by Boeing regarding the Barometric Pressure Setting in the new Subtype=1 Target State and Status Message and the use of QFE and QNH. The comment was resolved by adding a note under the BPS section:

Note: *This Barometric Pressure Setting data can be used to represent QFE or QNH/QNE, depending on local procedures. It represents the current value being used to fly the aircraft.*

8. In Working Papers TSG WP08-02R1 and ASP WP08-06 Vince Orlando describes proposed changes to GICB in SARPs and MOPS. After discussion during the TSG meeting in Fort Lauderdale 2010, there was agreement that there should be an additional test for DI=3. Tom Pagano and Don Walker will propose exact changes.

9. Working Paper TSG WP08-04 describes proposed changes to On-the-Ground Determination Algorithms. During the TSG meeting in Fort Lauderdale 2010, the TSG discussed the potential need for changes in Note 4 of §2.2.18.2.7 of DO-181D during Change 1. No specific changes were proposed, so the Note below will need to be reviewed and changes discussed and agreed.

> ***Note 4:*** *Modern aircraft with integrated avionics suites commonly contain sophisticated algorithms for determining the air/ground state based on multiple aircraft sensors. These algorithms are customized to the airframe and designed to overcome individual sensor failures. These algorithms are an acceptable means to determine the air/ground state and do not require additional validation.*

10. Bob Saffell initiated a series of email exchanges around 8-9 February 2010 based on what turned out to be the movement of the requirement to inhibit ATCRBS and Mode S All-Call while on-the-ground from DO-181C §2.1.7.b into DO-181D, §2.2.18.2.2.b and §2.2.18.2.3. Following is Bob's email response, which could lead to a change:

> "Looked at §2.2.18.2.2.(b) and §2.2.18.2.3 and looks like the requirements are there but not as specific as they were before in §2.1.7.b. Test is then done in §2.5.4.2, but the procedure is very broad based. That is, whoever writes a real procedure has to ensure that all formats are covered. Suspect that we can live with that. Biggest problem is that §3.3.14 is an installed equipment test and it has a good procedure but does not reference back to anything. Somehow, we will need to tie the §3.3.14 procedure back to §2.2.18.2.2.(b) and §2.2.18.2.3.
>
> Checked the ICAO Volume IV Amendment 82 requirement in §3.1.2.10.3.10 and the requirements are solid."
>
> **Status from a summary email from Saffell, dated 14 June 2010:**
> Went back and reviewed the issue discussed below and provide the following at this time:
> a. Virtually nothing in section 3.3 refers back to the requirements sections in 2.2, so I suspect that 3.3.14 does not really have to refer back to section 2.2.18.2.3.
> b. We probably should discuss the point in regards to section 2.5.4.2 being adequate to test section 2.2.18.3. If the group feels that it is adequate, then we probably don't have to do anything else in this matter.

11. Change(s) to incorporate the changes required to move Periodic Status Messages out from under the Event Driven Squitter protocol.

12. Change(s) to reflect changes in maximum squitter rate of 6.2 squitters per second averaged over 60 seconds.

13. Change(s) that will be required if non-reply to wide P4 is accepted by ASP. Working Papers being presented during the ICAO ASP Meeting the week of 26-30 April. Check the web page for the meeting at: http://adsb.tc.faa.gov/ICAOASP.htm

 © 20xx, RTCA, Inc.

14. Change(s) to modify existing text describing reply rate capability.

15. Bob Saffell reports a reference issue. Current Text is:
2.2.19.1.11 Broadcast Protocol
If a broadcast interrogation has been accepted (see §2.2.18.2.2), the minimum data link transponder shall make that information available at the appropriate interface.

The reference to §2.2.18.2.2 **should be** §2.2.19.1.1 in order to correlate with DO-181C which referenced §2.2.17.1.1 in §2.2.17.1.11.

16. The description for the Mode S Subnetwork Version Number in Bits 17 through 23 of Register 10_{16} in §2.2.24.3.2.2, Table 2-4 and Appendix B, Table B-3-16 should be updated to indicate that Version Number 5 will be compatible with Doc 9871, Edition 2 and DO-181D/ED-73C Change 1. The problem is that we also reference Annex 10 Amendment numbers and years, which will have to be discussed and agreed upon.

17. Kevin Wilson of Honeywell reports that:

Table B-3-48, Note 1 references 2.2.22.1.2.1.3. I think it should reference 2.2.22.1.2.1.

18. Kevin Wilson of Honeywell reports a minor clerical error in §2.2.24.6.3.b. Use of a duplicate word "of"

(1). The contents of ~~of~~ the character field of Register 20_{16} shall be set to ZERO (0).

19. Kevin Wilson of Honeywell reports that Section 2.2.23.1.8 has the following questionable reference:

"ACS, the 12-bit (bits 41 52) Altitude Code Subfield in ME shall (under control of the ATS subfield, §2.2.16.2.6.2.9) report the barometric…."

I think the reference should be 2.2.23.1.9.

20. Kevin Wilson of Honeywell reports that in section §2.2.18.2.1.c there is a potential error in a reference to the function G(x). The following correction should be made:

"G(x) is defined in 2.2.16.2.1 b. " should be "G(x) is defined in 2.2.18.2.1.b"

21. Kevin Wilson of Honeywell indicates that DO-181D (2.2.24.6.3.b) has specific requirements to zero Register 20_{16} after a 10 second timeout. However, Register 08_{16} has no specific requirements and has conflicting notes. The Note in DO-181D (2.2.23.1.4.2) says that Register 08_{16} should not be cleared on timeout. But the Note in DO-181D (2.2.24.6.2.1) says that following requirements (for 20_{16}) should also apply to Register 08_{16}…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_{16} and 20_{16}) and they should probably be handled the same way.

Bob Saffell of Rockwell Collins produced what is recorded as Working Paper SC209-WP10-04 for review during the Joint Meeting at EUROCAE, and proposes changes to DO-181D/ED-73C, ICAO Doc 9871, DO-260B and ARINC 718A, Supplement 3.

22. Eric Potier indicates that when preparing a response to a question coming from a member of SC147, I noticed the following possible error in DO-181D section 3.3.3.

It states:

"Interrogate the installed transponder and verify that the reply frequency of the system is 1090 +/- 3 MHz for aircraft operating below 15,000 feet, or 1090, 1MHz for aircraft operating above 15,000 feet."

It was true for Mode A/C transponders but it is no more true for Mode S transponders and it is inconsistent with section §2.2.3.1 which states that "the carrier frequency of all downlink transmissions from transponders with Mode S capabilities shall be 1090 MHz plus or minus 1 MHz."

In ED-73C section the corresponding section is:
6.4.4.1 Reply Frequency
Interrogate the installed transponder and verify that the reply frequency is 1090 ± 1 MHz for both Class 1 and Class 2 equipment.

Therefore I believe the text in DO-181D section 3.3.3 should be:

Interrogate the installed transponder and verify that the reply frequency of the system is 1090 +/- 1 MHz.
(This has been agreed to by Bob Saffell via email on 14 June 2010)

 © 20xx, RTCA, Inc.

Draft

SC209/WG49-WP11-17 DRAFT Change 1 to DO-181D