RTCA Special Committee 209

ATCRBS / Mode S Transponder

Meeting #5

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Proposed Revisions to Section 1 to Introduce a Breakdown of Level 2 Transponders

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SUMMARY

This Working Paper presents a proposed set of revisions to text in Section 1 of the draft of DO-181D for the purpose of introducing a breakdown of Level 2 Transponders as was discussed during Meeting #4.

1.4.3 Mode S Transponder Levels

Mode S transponders provide for both ground-to-air and air-to-air surveillance.

The data link function of Mode S transponders provides for information transfer in both directions between ground and air and between airborne units. Data link implementation varies and depends on the amount of information to be exchanged.

Possible implementation configurations and additional transponder features are summarized in the following paragraphs.

1.4.3.1 Level 1 Transponders

The Level 1 Transponder supports the surveillance functions of both ATCRBS and Mode S ground sensors and the surveillance functions of airborne interrogators. This transponder can also reply to an airborne interrogator thereby making its presence known; to do this, it need only handle short interrogations and generate short replies.

Level 1 Transponders support the following capabilities:

a. Mode A identity and Mode C pressure-altitude reporting,
b. Intermode and Mode S all-call transactions,
c. Addressed surveillance altitude and identity transactions,
d. Lockout protocols,
e. Flight Status Reporting,
f. Air to Air reply information.

Note: *Level 1 permits SSR surveillance based on pressure-altitude reporting and the Mode A identity code. In an SSR Mode S environment, technical performance relative to a Mode A/C transponder is improved because of Mode S selective aircraft interrogation.*

1.4.3.2 Level 2 Transponders

The Level 2 Transponder supports all of the surveillance functions supported by a Level 1 Transponder. It also supports:

a. bidirectional air-to-air information exchange,
b. ground-to-air data uplink, Comm-A,
c. air-to-ground data downlink, Comm-B,
d. ~~multisite message protocol~~ data link capability reporting,
e. aircraft identification reporting,
f. ACAS crosslink capability.

Level 2 Transponders support receipt and processing of long interrogations and the generation of long replies. The ground-air-ground data link capability comprises a multitude of services and can be implemented according to the number and kind of services available, depending on the mission requirements of the aircraft. Protocols provide a means of reporting to the ground the specifics of each individual installation. The Comm-B multisite protocol allows multiple Mode S ground interrogators to extract data from the transponder under their control.

A Level 2A transponder consists of all the Level 2 requirements with the exception of the capability to send or announce air-initiated Comm-B messages. A Level 2A transponder is permitted in installations that do not require initiating air-to-ground messages. These transponders support the extraction from the ground of the ground initiated Comm-B registers and Comm-B broadcasts, but do not implement the air-initiated Comm-B protocol (see sections xxxxx). Therefore, these transponders do not set the B bit requesting to send a Comm-B message. A Level 2A transponder is sufficient to support other optional features including TCAS, Extended Squitter, Elementary Surveillance Compliant (ELS) transponder and Enhanced Surveillance Compliant (EHS) transponder capabilities. If TCAS is included in a Level 2A implementation, the transponder includes the capability of providing and announcing the TCAS Resolution Advisory Report. Extended Squitter is an optional capability that broadcasts position and other information that is used by ground systems and other aircraft. The Extended Squitter capability must meet the requirements of RTCA Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B), RTCA DO-260A, including Change 1 and Change 2. ELS and EHS capable transponders are required in certain European airspace and requirements are included in this document.

Note: *Level 2 permits aircraft identification reporting and other standard length data link communications from ground-to-air and air-to-ground. The aircraft identification reporting capability requires an interface and appropriate input device.*

1.4.3.3 Level 3 Transponders (Uplink ELM Capability)

In addition to the capabilities of the Level 1 and Level 2 Transponders, the Level 3 transponder is able to receive ELMs from the ground. ELMs are received in the Comm-C format and consist of a burst of uplink transmissions that need not be replied to individually but are acknowledged in a reply containing a summary of the received interrogations.

Level 3 Transponders **shall** have the capabilities of §1.4.3.2 and also those prescribed for ground-to-air extended length message (ELM) communications.

Note: *Level 3 permits extended length data link communications from ground-to-air and thus may provide retrieval from ground-based data banks and receipt of other air traffic services which are not available with Level 2 transponders.*

1.4.3.4 Level 4 Transponders (Full ELM Capability)

In addition to all the capabilities of a Level 3 Transponder, the Level 4 Transponder can generate ELMs for transmittal to the ground by using the Comm-D format.

Level 4 transponders **shall** have the capabilities of §1.4.3.3 and also those prescribed for air-to-ground extended length message (ELM) communications.

Note: *Level 4 permits extended length data link communications from air to ground and thus may provide access from the ground to airborne data sources and the transmission of other data required by air traffic services which are not available with Level 2 transponders.*

1.4.3.5 Level 5 Transponders (Enhanced Data Link Protocol Capability)

In addition to the full ELM capability, the Level 5 Transponder can support the enhanced data link protocols. The protocols provide for increased data link capacity by permitting data link transactions with more than one Mode S interrogator at a time without the need for multisite coordination. These protocols are fully conformant to the data link transponder protocols description of §2.2.19.1 to §2.2.20.2.1 (the standard protocols) and are therefore compatible with interrogators that are not equipped for the enhanced protocol.

Level 5 transponders **shall** have the capabilities of §1.4.3.4 and also those prescribed for enhanced Comm-B and extended length message (ELM) communications.

Note: *Level 5 permits Comm-B and extended length data link communications with multiple interrogators without requiring the use of multisite reservations. The Level 5 Transponder has a higher minimum data link capacity than the other transponder levels.*

1.4.3.6 Additional Features

Some transponder installations will require additional features:

- Installations in large aircraft or co-installation with airborne collision avoidance systems may require the transponder to operate in the diversity mode, i.e., the use of two antennas, receivers and transmitting channels.

- Co-installation with TCAS II systems requires capability for long air-to-air formats.

- Co-installation with other L-band equipment may require an on-board mutual suppression system.

- Extended squitter capability can be included in transponders meeting the requirements of Level 2A, Level 2, Level 3, Level 4 or Level 5, and also those prescribed for extended squitter operation. The Level 2 transponder need not include the air-initiated Comm-B. Transponders with this capability **shall** be designated with a suffix “e.”