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EUROCAE WG-51, SG-1

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Review of Issues with ADS-B Independent Fail/Warn and ON/OFF In Response to Action Item 24-12

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Summary
Response to Action Item 24-12. This Working Paper addresses implementation issues with possible attempts to require and independent Fail/Warn indication for ADS-B OUT functions. Likewise, the Working Paper also briefly addresses implementation issues with possible attempts to require an ADS-B ON/OFF control for the ADS-B OUT functions.

1. Introduction

The recent SC-186 WG-3 Phoenix Meeting and the ICAO ASP TSG Meeting in Ft. Lauderdale both held preliminary discussions in regards to providing an independent ON/OFF and an independent Fail / Warn Capability for the ADS-B OUT function. Currently, legacy Air Transport Transponders only provide a single Standby/ON function and a single Fail / Warn function. The subsequent paragraphs point out the issues with attempting to add independent control and Fail / Warn capability for the ADS-B OUT function.

2. Current Fail / Warn Requirements

RTCA DO-181D currently provides:

> **"2.2.10.4 Failure Annunciation**
>
> An output **shall** be provided to indicate the validity/non-validity of the transponder. Failure to generate squitters at the nominal rate, a failure detected by self-test or the monitoring function, or failure of Mode S address verification **shall** cause the output to assume the invalid state. Momentary power interrupts **shall not** cause the output to assume the invalid state. The status of the transponder **shall** be annunciated to the flight crew."

Other than the conditions given in RTCA DO-181 (as shown above, and similarly provided in Eurocae ED-73C), the transponder should not be declared to have failed unless it cannot properly complete interrogation / reply transaction cycles.

3. Problem with Current Fail / Warn Requirements

The most pronounced problem with the Current Fail/Warn Requirements is that there is only one Fail/Warn annunciation requirement. This means that most, if not all legacy transponders, have only one Fail/Warn lamp to indicate all failures. This makes it impossible to distinguish if a failure has been set based on transponder basic functions or due to ADS-B OUT problems.

4. Problem with Current Fail / Warn Implementations

As would be expected based on the requirements, legacy transponder and transponder Control Panels only provide for one Fail/Warn indication. This indication is typically established by the transponder setting an output discrete active to turn on the Fail/Warn lamp on the control panel.

As a minimum, any requirement to add an independent Fail/Warn mechanism for the ADS-B OUT function would require:

a. An additional output discrete for the transponder assigned as ADS-B OUT Fail Warn.

> ***Note:*** ARINC-718A has recently been updated to ARINC-718A-2 which provides reassignment of the input/output functions to provide for the needs of the currently proposed US NPRM. At this time, there are NO MORE PINs available for reassignment that would not cause serious impact to proposed aircraft installations.

b. The Transponder Control Panel would need to be modified to accept the new discrete proposed in subparagraph "a". Likewise, the Control Panel would need to be modified to provide another Fail/Warn lamp for the ADS-B OUT function.

Note: Modification or re-design of the Control Panel will not be a popular move as the Control Panels were modified in recent years to provide for Flight Identification capability as required by Elementary Surveillance mandates in Europe.

c. The aircraft wiring installation would have to be updated to provide the necessary wiring to connect the discrete discussed in subparagraph "a" to the modified Control Panel discussed in subparagraph "b".

In short, any move to require an independent Fail/Warn mechanism for the ADS-B OUT function will present serious cost and operational schedule impact to existing legacy transponder installations.

Although not much of an improvement, there is an alternative to providing the discrete output discussed in subparagraph "a". ARINC 718-4 and ARINC 718A Control Panels do provide ARINC Input buses that could be wired to the transponder Maintenance Bus. This would remove the need to change transponder hardware. Software would still need to be updated in the transponder to set an appropriate ADS-B OUT Fail/Warn bit in the ARINC word transmissions to the Control Panel. The transponder Maintenance bus would need to be wired to the Control Panel and the Control Panel would then need software and hardware modifications to establish the Fail/Warn indication. Again, considerable impact would be presented to existing legacy transponder installations.

5. Proposed Fail/Warn Solution

Having reviewed some of the issues regarding an independent ADS-B OUT Fail/Warn indication, the following proposes a minimum capability that could be implemented with minimal impact to some aircraft.

For aircraft that do not provide monitoring of the transponder Maintenance Bus, any independent ADS-B OUT Fail/Warn capability would need to be addressed as discussed in section "4".

Many legacy aircraft do implement CFDIU, CMC, or AIMs systems which provide for monitoring of the transponder Maintenance bus. As a minimum, these systems usually monitor the label "350" Maintenance diagnostic word that is periodically transmitted by the transponder. For these aircraft, a minimum independent ADS-B OUT Fail/Warn capability could be established as follows:

a. Modify the transponder software to transmit additional maintenance words (e.g., label "351", "352", etc.) which would contain appropriate fault bits to declare extended squitter failures on a per squitter or message type basis.

b. Modify the CFDIU, CMC, AIMS or other maintenance monitor to process the new maintenance words discussed in subparagraph "a" and then establish appropriate annunciations for the faults that could be reviewed by the flight crew by reviewing the transponder Maintenance pages.

c. Retain, the single Fail/Warn indication that is currently employed by the transponder and Control Panel Pair.

Now, when the Fail/Warn is indicated on the Control Panel, the flight crew can select and review the transponder Maintenance page and determine if the Fail/Warn is being caused by ADS-B OUT issues.

It should be noted that this method could have utility for aircraft that do not have Maintenance monitoring systems since the output maintenance words could be reviewed via bus readers during ground troubleshooting procedures.

6. On / OFF Control of ADS-B OUT

In general, SC-186 WG-3 and the ICAO ASP TSG have indicated that it is not desirable to have capability to independently turn the ADS-B OUT function ON or OFF. Such issues are addressed in other working papers in the Brussels meeting. The purpose of this paper is to point out implementation issues if one should force implementation of an ADS-B OUT ON/Off capability. Such issues are addressed as follows:

a. ARINC-718A Control Panels would need to be modified to provide additional switch positions to turn the ADS-B OUT function ON and/or OFF. The easiest would be to provide a single ADS-B OUT ON/OFF Switch.

   This action would require extensive redesign and certification of the legacy transponder Control Panels. A move that will not be popular as the Control Panels were recently upgraded to provide Flight Identification data required by the Elementary Surveillance mandates in Europe.

b. The switch provided in subparagraph "a" would then need to be wired to a relay in the equipment bay which upon activation would then apply aircraft ground to transponder pin **MP-5G**, "Extended Squitter Disable".

   This action presents serious impact to the aircraft installation as it forces addition of a connection between the Control Panel, a 28 VDC relay, and the transponder.

   Note: **MP-5G**, "Extended Squitter Disable" is defined as a low-level discrete and was intended as a configuration strap input. That is, the overall installation either has Extended Squitter capability or it Does Not. The function was NOT intended to be dynamically switched. The function has been retained through ARINC -718A specification activity for troubleshooting purposes of the transponder when interrogation and reply synchronization to the oscilloscope is necessary.

   As the discrete input is defined as a low level discrete, a dynamic installation will need to employ a relay to apply ground in order to meet the guaranteed low value of the transponder input logic circuitry.

c. Once the controls have been provided as described in subparagraph "a" and "b", an appropriate ADS-B OUT Fail/Warn mechanism would still need to be employed as discussed in section "5".

7. Closure

RTCA SC-186, WG-3 and EUROCAE, WG-51, SG-1 are invited to review issues discussed above and establish appropriate methods to deal with the issues.