

RTCA Special Committee 209

ATCRBS / Mode S Transponder MOPs Maintenance

Meeting #11

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**P5 Pulse Position Differences
Between
DO-181D and Annex 10 Vol. IV / ED-73C**

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This Working Paper is provided in response to **Action Item 10-11**.
The Working Paper addresses the differences regarding specification of the pulse spacing from the P5 Pulse to the Sync Phase Reversal as specified in RTCA DO-181D and other relevant industry documents.

Introduction / Discussion:

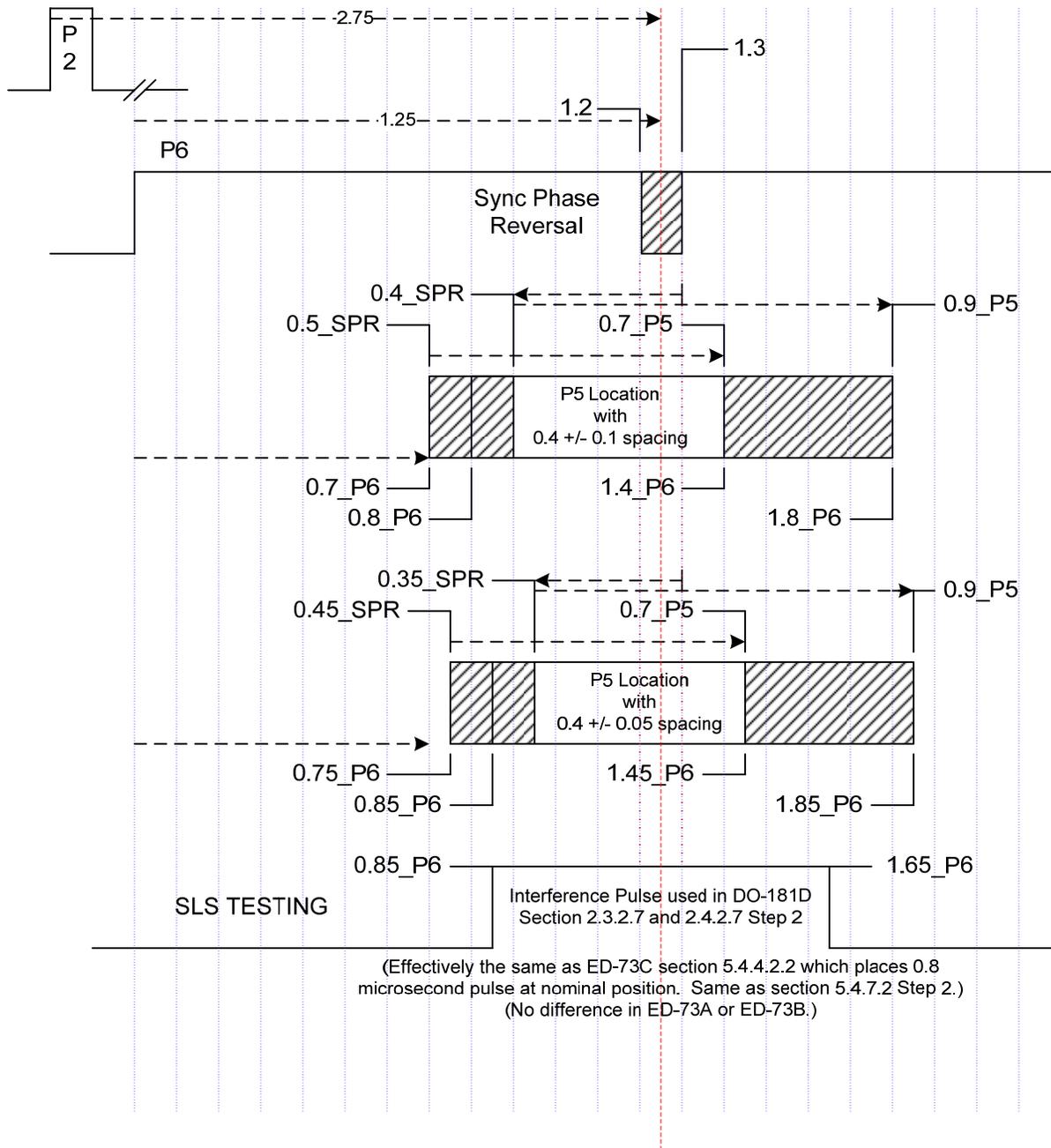
During SC209 Meeting #10, Action item #10-11 was assigned to research and attempt to explain the differences in P5 to Sync Phase Reversal (SPR) spacing specified in various industry documents.

The following table lists the requirements for P5 -to- SPR spacing as provided in available industry documents.

P5 TO SYNCH PHASE REVERSAL REQUIREMENTS COMPARISON LIST			
Document	Section	Date	Requirement
DO-181D	2.1.11.4.4	October 2, 2008	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181C	2.1.11.4.4	June 12, 2001	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181B	2.1.11.4.4	July 29, 1999	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181A, Change 3	2.1.11.4.4	November 24, 1997	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181A, Change 2	2.1.11.4.4	January 27, 1997	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181A, Change 1	2.1.11.4.4	January 14, 1993	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181A	2.1.11.4.4	January 14, 1992	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181, Change 3	2.1.11.4.4	April 9, 1991	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181, Change 2	2.1.11.4.4	January 17, 1986	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181, Change 1	2.1.11.4.4	November 13, 1984	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
DO-181	2.1.11.4.4	March, 1983	P5 to synch phase reversal 0.4 +/- 0.1 microseconds
ARINC 718A-3	Appendix A and 4.2.8.4	June 30, 2010	Same as ARINC 718A
ARINC 718A-2	Appendix A and 4.2.8.4	February 23, 2009	Same as ARINC 718A
ARINC 718A-1	Appendix A and 4.2.8.4	March 15, 2004	Same as ARINC 718A
ARINC 718A	Appendix A and 4.2.8.4	February 15, 2002	P5 = 0.8 μs pulse, spaced 2.35 μs from P2 (overlying synch phase reversal) Tolerance of SPR from P2 given as +/- 0.05 μs in section 4.2.8.4. This makes ARINC 718A consistent with the 0.4 +/- 0.05 P5 to SPR given in Annex 10 and ED-73-A/B/C
ARINC 718-4	3.3.2.2.7.1	December 15, 1989	P5 to synch phase reversal 0.4 +/- 0.05 microseconds
ED-73_A/B/C	1.6.4.e		P5 to synch phase reversal 0.4 +/- 0.05 microseconds
ICAO, Vol. IV, Amendment 82	3.1.2.1.5.2.5		P5, if transmitted, shall be centered over the sync phase reversal; the leading edge of P5 shall occur 0.4 plus or minus 0.05 microseconds before the sync phase reversal.
ICAO, Vol. IV, Amendment 77	3.1.2.1.5.2.5		P5, if transmitted, shall be centered over the sync phase reversal; the leading edge of P5 shall occur 0.4 plus or minus 0.05 microseconds before the sync phase reversal.

Review of the table indicates that RTCA DO-181X has always listed the P5 –to- SPR spacing as 0.4 +/- 0.1 microseconds. Conversely, ICAO Annex 10 Volume IV, Eurocae ED-73, and ARINC 718-4 and 718A documents all list the spacing as 0.4 +/- 0.05 microseconds.

The following figure illustrates the worse case pulse positions possible for both the 0.4 +/-0.5 microsecond and for the 0.4 +/- 1.0 microsecond spacings. As shown, both conditions will easily ensure that the P5 position will properly obscure the sync phase reversal and thereby cause non-acceptance of the Mode-S interrogation if the P5 amplitude is sufficient. The figure also illustrates that the same P5 pulse position is used for testing Mode-S SLS in both RTCA DO-181D and in Eurocae ED-73C.



Conclusion / Recommendation:

Review of the figure above indicates that there probably is little functional difference when having a P5 position tolerance of +/- 0.1 or +/- 0.05 microseconds. Either case will properly mask the sync phase reversal.

Considering that the ICAO documents appear to have always used a tolerance of +/- 0.05 microseconds, the recommendation is to change the RTCA DO-181D spacing to be the same as ICAO Annex 10. That is, **change** RTCA DO-181D section 2.1.11.4.4 to specify a **P5 to sync phase reversal spacing of 0.40 +/- 0.05** microseconds. There is no impact to the current test procedure provided in either RTCA DO-181D or Eurocae ED-73C.